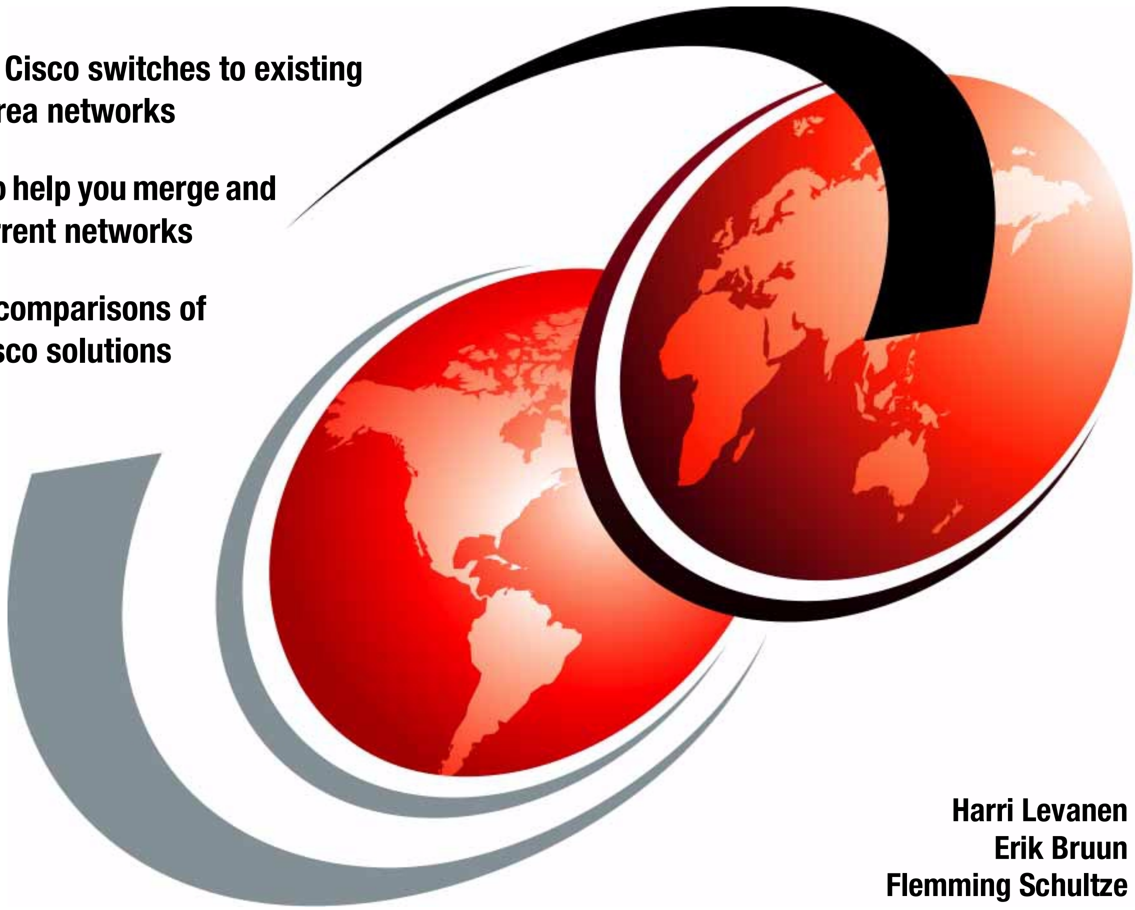
IBM and Cisco LAN Switching

An Interoperability and Migration Guide

How to add Cisco switches to existing IBM local area networks

Examples to help you merge and migrate current networks

Functional comparisons of IBM and Cisco solutions



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International Technical Support Organization

IBM and Cisco LAN Switching
An Interoperability and Migration Guide

May 2000

Take Note!

Before using this information and the product it supports, be sure to read the general information in Appendix C, "Special notices" on page 129.

First Edition (May 2000)

This edition applies to IBM and Cisco networking hardware and software.

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Contents

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Preface

In December 1999, regulatory authorities in the USA approved a strategic alliance between IBM and Cisco. Subsequently, authorities in other countries who investigated the terms of the alliance have also approved it. As a result, IBM Global Services will market Cisco networking products to complement IBM's solution offerings. IBM's current line of routers and Ethernet and ATM switches will be withdrawn gradually over the course of the following 12 months.

This IBM Redbook will help anyone who has an IBM campus/LAN network today. Where is this network going to go, given that IBM is no longer developing and selling Ethernet and ATM LAN hardware? How is the network infrastructure to evolve? What are the implications of adding hardware from other vendors to an existing network? This book looks at some of the possibilities available when adding Cisco switching equipment to these existing networks. It explains the similarities and differences between the IBM and Cisco product lines and shows how networks can be constructed using a mixture of equipment from both vendors.

This book will help users of IBM Ethernet and ATM switches plan for the growth and eventual migration of their existing networks. A companion redbook, *IBM Router Interoperability and Migration Examples*, explores how to expand and migrate IBM router networks.

Guidelines given in this IBM Redbook are general. Several scenarios are included, and although actual customer networks will differ, these scenarios serve as examples for you to develop proper plans to expand or migrate your networks to meet future business requirements.

Customers are invited to engage IBM in the planning process.

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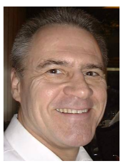
The team that wrote this redbook

This redbook was produced by a team of specialists from around the world working at the International Technical Support Organization, Raleigh Center.

Harri Levanen is an Advisory Campus LAN specialist at the International Technical Support Organization, Raleigh Center. He has six years of experience in the networking area. His areas of expertise includes ATM switches, LAN switches and Network Management. Before joining the ITSO in early 1999, Harri worked in IBM Global Services in Finland.

Erik Bruun is an Advisory I/T Specialist for networking in IBM Denmark. He has twelve years of experience in networking area and has worked for two and half years in IBM Global Services - Integrated Technology Services, with responsibility for networking design and implementation as well as product support. His areas of expertise includes ATM switches, LAN switches and Network Management.



Flemming Schulze is Senior Networking Marketing Specialist in IBM Global Services in Denmark. His networking career began in 1977 when he led a group in Milan, Italy, to market and support SNA interoperability between mainframes and small systems. Subsequently he had responsibility for marketing the NetView suite of management products for System/370 in Denmark, and through the 1990s he worked in the European marketing organization of IBM Networking Hardware Division designing and marketing solutions for customers in the Nordic countries.

Thanks to the following people for their invaluable contributions to this project:

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Cisco, Raleigh

Comments welcome

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Chapter 1. Planning interoperability and migration

Migration takes place when moving from one technology to another, or from one generation of equipment to another, or from one brand of products to another. Most customer organizations have gone through several migrations of their network. Migration of networking technology is desirable to provide additional functions, increased capacity, or improved cost efficiency to meet business requirements.

Migration is nothing new. Most organizations have been through several migrations of networking technology. Migrations take place when moving from one technology to another or from one generation of equipment to another, irrespective of the brand.

Similarly, most networks are made up of diverse brands, for example modems from one manufacturer, multiplexors from another, and controllers or routers from still a third manufacturer, or hubs and switches from different manufacturers.

The IBM - Cisco alliance prompts the process of planning for increased interoperability between diverse brands and eventually for a future migration. Whether this planning is necessary for the short term or for the long term, the alliance is an opportunity for organizations to review and consolidate current plans.

The research and laboratory exercises that were done to support the recommendations in this guide showed that in most cases standards-based products really do work together. For the most part, we found that interoperability was easily accomplished. It is our opinion that customers may be able to take advantage of such interoperability when applied with caution.

In some cases during the course of testing interoperability, IBM Networking Hardware Division and Cisco System developers encountered minor problems resulting from implementation differences. In most cases, these problems were readily fixed, and in other cases we document our recommendations to avoid problems rising from limitations of interoperability.

Important

Customers should plan their future networking strategies in conjunction with IBM Global Services. Contact information can be found at `http://www.ibm.com/planetwide`. In the following sections of this book we detail our recommendations in this respect.

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1.1 Migration methods

There are several ways to migrate. Most organizations have experience with one or more of these methods. For reference, we will briefly review the most common methods for providing growth and additional functions to a network.

1.1.1 Step-by-step box addition or replacement

As requirements for additional ports, capacity, or function arise, new equipment is inserted into the network. Frequently, this equipment is of a newer generation, and sometimes of another brand, than the existing equipment. Over time all the original equipment is replaced. This is illustrated in Figure 1.

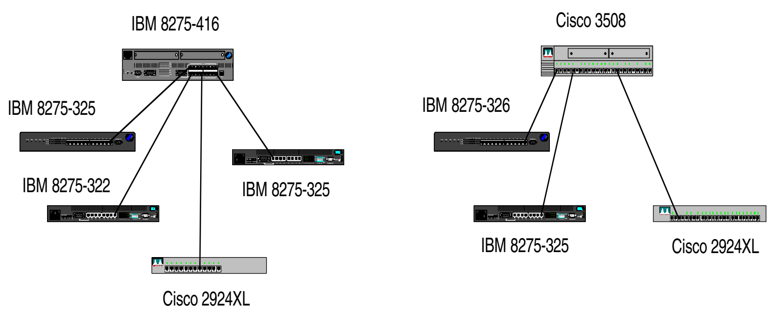

Figure 1. Step-by-step box addition or replacement; some boxes are replaced, some are added

The approach in this scenario is widely used. It is often simple and straightforward to implement. However, interoperability is an issue that must be carefully planned.

Most of the networking equipment in the marketplace implement standards for interoperability. IBM and other manufacturers acknowledge the legitimate rights of customers to mix and match standards-based equipment and will provide defect support to solve interoperability issues if necessary. This redbook is an example of how IBM and Cisco cooperate to assure interoperability between like products in the interest of the customers.

In this redbook, several scenarios are described in more detail, and examples are given of Cisco products that interoperate with IBM Ethernet and ATM switches and may be used to expand capacity and function in a mixed environment.

1.1.2 Cutover migration

The term *cutover migration* describes the case where all or almost all existing equipment is taken out at once, or over a brief period of time, and replaced with new equipment. See Figure 2. This method is sometimes referred to as *forklift* migration. A cutover migration may be staged, taking a piece of the network at a time.

Figure 2. Cutover migration; all boxes are replaced

Many Ethernet users have gone through migration from 10Base2 to 10Base-T, and again from 10Base-T to 100Base-T. However, interoperability between the network devices is straightforward, leaving the customer to migrate at his own pace.

1.1.3 Overlaying network

It may be desirable to operate two networks simultaneously - the new network together with the existing, old network. See Figure 3. This is often the case if the new network differs considerably from the existing network, or if applications or existing equipment depend on the old network and cannot be converted easily or economically to connect to the new network.

For example, devices may depend on specific application code. This was often the case with older printers using a BSC or asynchronous protocol. Altering the old applications may not be feasible, and the only option is to keep the old network in parallel with the new until the time when the old applications are phased out and the old printers may be replaced with new ones that can connect to the new network.

Another instance where an overlay migration approach may prove desirable is in the case of a circuit-switched or cell-switched network providing connectivity between private telephone exchanges (PBXs). To extend such a network with the capability to support current frame-based and Ethernet technologies such as Voice over IP (VoIP), an overlay network may be deployed.

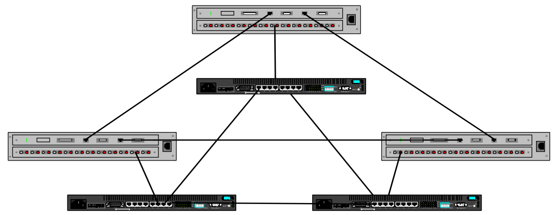

Figure 3. Overlaying network

To avoid the cost of parallel trunks, customers may want to speed the migration of boundary equipment to the newer technology.

1.1.4 Adding more levels to a hierarchy

As network size and traffic volumes increase, it may be desirable or required to add more levels to the network. As an example, picture the network in Figure 4 consisting of IBM ATM switch nodes 1, 2, 3, 4, 5, and 6 connected in a mesh network. We wish to expand by:

1. Adding nodes 7, 8, 9, and 10.
2. Adding nodes 100, 200, 300 and 400 to increase bandwidth capacity of the backbone to support new applications such as imaging.

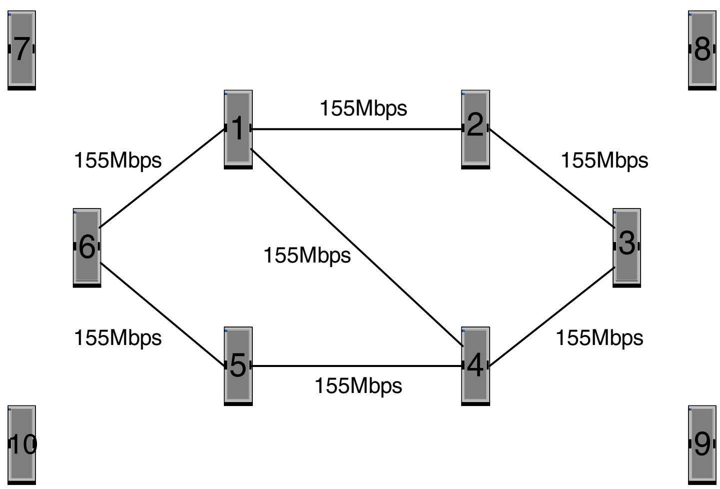

Figure 4. Adding more levels: edge nodes

By inserting an additional hierarchy of faster backbone switches, as shown in Figure 5, network topology is simplified and enabled for growth. Higher level functions will then have access to the faster backbone and can grow as needed.

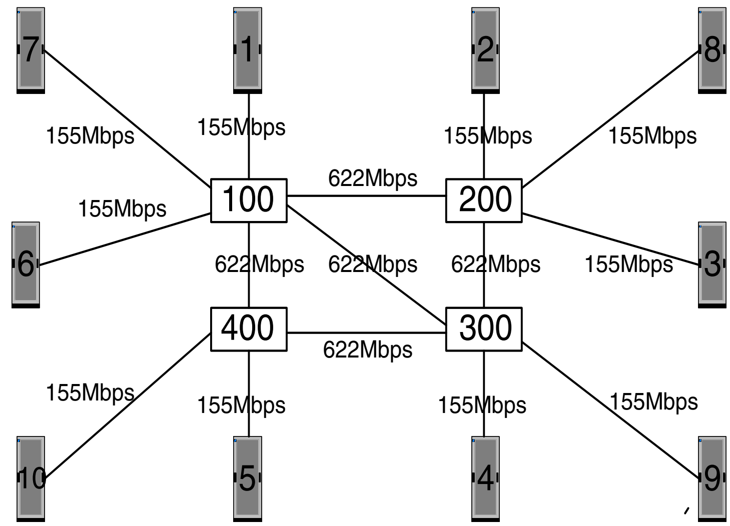

Figure 5. Adding more levels: backbone bandwidth

1.2 Network management

Management of the network is a major consideration when choosing a strategy and selecting vendors. This redbook deals with the aspects of migrating switching hardware, and detailed considerations regarding management software products are beyond its scope. We do, however, contribute a few general thoughts.

Ideally, only a single management platform should be necessary to manage all information technology resources, including the network. In reality, such a platform hardly exists, but the product suite from Tivoli Systems Inc., an IBM company, constitutes a good attempt to deliver comprehensive support.

Tivoli NetView acts as host for CiscoWorks2000 as well as for IBM Nways Manager for operation management and automation. Tivoli Enterprise for asset and change management likewise provides integration with both of these element managers.

Tivoli product information is found at `http://www.tivoli.com`. IBM Global Services offer consulting and services to plan and implement Tivoli Enterprise products. See `http://www.as.ibm.com/tivoli.html`.

Chapter 2. Functional comparisons

In this chapter, we first talk about features that are pertinent when selecting Ethernet and ATM switches from different vendors for interworking.

We compare IBM networking hardware feature by feature with alternative products. As a consequence of the alliance between IBM and Cisco, we naturally look for Cisco equipment that is similar to and may supplement or substitute for IBM products. Both IBM and Cisco support industry standards.

There is a multitude of different products that may complement or replace IBM switches. Customers are encouraged to evaluate aspects other than sheer interoperability when making an evaluation. But for the purpose of this redbook we limit the discussion and the comparisons to alternatives that we believe to be the closest match in functionality to any given existing equipment.

Caution

In many cases, addition or substitution of equipment from a different vendor is trouble free. In other cases, even if the new equipment has the same or equivalent functions as the old, interoperability may not be practical. Cutover migration may be necessary, and design changes to the network may be required or desirable. This is particularly true when it comes to advanced functions such as self-learning IP routing or hot standby/redundant gateways.

2.1 Ethernet switches

The following IBM Ethernet switches are considered for interoperability in this redbook:

- IBM 8271
- IBM 8274
- IBM 8275
- IBM 8277
- IBM 8371

2.1.1 Criteria for comparison

In this section we discuss interoperability of major functions such as:

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- Auto-speed negotiation
- Flow control
- Spanning tree protocol
- VLAN functions
- Traffic prioritization
- Link aggregation
- Layer-3 routing

In addition we make some general observations that were made during the course of interoperability testing as they relate to each of these criteria.

Other functional characteristics such as modularity, scalability, management, number of MAC addresses, and performance are obviously relevant when choosing an Ethernet switch. But since these qualities have no direct bearing on interoperability, they are left out of this discussion.

2.1.1.1 Auto-speed negotiation

Auto-speed negotiation is firmly based on the IEEE 802.3 standard. All tests were passed successfully. However, connecting differently configured ports, such as auto-speed to fixed speed, could cause negotiation to take a long time or fail.

> **Tip**
>
> When connecting two 10/100 switch ports configured to auto-speed, they will almost always negotiate the highest speed and full duplex. However, if you want to be sure that the best performance is achieved, you must set *both* ports to the desired fixed configuration. Do *not* connect a port with auto configuration to a port with a fixed configuration.

2.1.1.2 Flow control

To prevent overflow in case of output congestion, early Ethernet switches provided back pressure by transmitting a random carrier signal. This works fine on half-duplex ports, but would have no effect on full duplex ports. IEEE 802.3 specifies a flow control technique whereby a receiving port can signal to the transmitting port to stop or resume sending frames - somewhat analogous to the XON/XOFF signaling we know from asynchronous communication.

IEEE 802.3x flow control between IBM and Cisco switches was verified successfully.

2.1.1.3 Spanning tree protocol

The spanning tree protocol, part of the IEEE 802.1d specification, prevents loops in a meshed network of Ethernet switches (or bridges).

> **Note**
>
> Make sure that the higher performance switch is the root switch in networks with many switches.

Our interoperability tests verified that either the IBM switch or the Cisco Catalyst switch could be the root bridge, and that either switch could be forced to become the root bridge.

> **Caution**
>
> In small networks with few switches, the spanning tree protocol rarely gives rise to difficulties. However, to install and operate larger Ethernet switch networks successfully, it is of paramount importance that spanning tree parameters are configured carefully, or extended network outages may result. Do *not* automatically assume there is an interoperability problem if problems of network stability arise as Catalyst switches are added to a network of IBM switches. It may well be a problem of configuring the spanning tree protocol correctly.

2.1.1.4 VLAN functions

IEEE 802.1Q port-based VLAN interoperated successfully. In Chapter 3, “Ethernet switch interoperability” on page 25, we provide a detailed example of how to configure a VLAN across an IBM 8275 and a Catalyst 2924. Make sure that all the boxes where you plan to use IEEE 802.1Q really support it.

> **Tip**
>
> On the switches we sampled, only VLAN 1 (the default VLAN) could connect to the management functions of the switch. To ease configuration management, we suggest that you leave one port on each switch in VLAN 1, and that VLAN 1 is not excluded from travelling across trunks. However, be cautious of the security exposure if servers or clients are inadvertently connected to a VLAN 1 port.

2.1.1.5 Traffic prioritization

IEEE 802.1p Specification is part of the IEEE 802.1D Standard, “Standard for Local Area Network MAC Bridges”, and adds support for traffic priority to LAN

bridges. The standard supports eight classes (priorities) of services (COS), and the LAN devices (switches/bridges), can have any number of transmission queues on each interface, all the way from one queue for all traffic to one queue for each transmission priority. High priority frames will be forwarded before low priority if cut-through mode is not used. A value of 0 means routing services with lowest (no) priority, and a value of 7 might be a time-critical traffic with highest priority. Typically there are only two queues, and priorities from 0 to 3 will be forwarded as normal (low), and 4 to 7 as highest priority.

2.1.1.6 Link aggregation

Link aggregation, or trunking, was first implemented by Sun Microsystems for the purpose of providing more bandwidth between a server and the network. The SunTrunking 1.0 specification has likely been the basis for several other proprietary implementations of link aggregations, including Cisco's EtherChannel Phase I, to the extent that they interoperate. IBM 8275 Model 416 and on IBM 8371 Model A16 support EtherChannel Phase I. Though not formally announced, IBM has verified that the link aggregation implementation of IBM 8275 Models 2xx and 3xx is compatible with EtherChannel Phase I. We have verified this compatibility and provide a configuration example in Chapter 3, "Ethernet switch interoperability" on page 25.

The emerging international standard for link aggregation, IEEE 802.3ad, is barely implemented in commercially available switches. It will likely be the preferred technology for link aggregation in the future. However, since SunTrunking and EtherChannel seem to do the job, they will probably be around for a long time.

2.1.1.7 Layer-3 routing

The following IBM Ethernet switches provide layer-3 functions:

- IBM 8275 Model 416
- IBM 8274 and IBM 8277
- IBM 8371

The functions tested for interoperability are the RIP and OSPF routing protocols.

In addition to routing, layer-3 equipment often perform several functions that are internal to the equipment such as filtering and access control lists. Since these functions are internal to the equipment, they are not an issue for interoperability, but users must nonetheless verify that equivalent functions

are available on equipment selected to supplement an existing network of IBM products.

Self-learning IP routing

IBM 8275 Model 416 supports a simplified routing scheme called self-learning IP routing as its only layer-3 function. This function is also supported on IBM 8371 in addition to full-function layer-3 routing. Self-learning IP routing was first developed as a technology by Bay Networks, and this vendor supports it today on several of its current switch products. Cisco Systems provides a similar function through the NetFlow Feature Card option for the Catalyst 5000 series or the Multilayer Switch Feature card for the Catalyst 6000 series.

Virtual Router Redundancy Protocol (VRRP)

IBM 8371 supports an IETF-based implementation of default gateway redundancy, VRRP, RFC 2338. VRRP on IBM 8371 interoperates with VRRP on the IBM 22xx router series. Cisco Systems deliver a similar function in a proprietary implementation, Hot Standby Router Protocol (HSRP). VRRP and HSRP are not interoperable.

2.1.2 Comparison of IBM and Cisco Ethernet Switches

The Cisco 2924M XL is chosen here because of its ATM uplink. If there is no need for ATM, other models might do as well.

Table 1. IBM 8271-712 compared to Cisco 2924M XL

	IBM 8271-712	**Cisco 2924M XL**
IEEE802.3 10Base-T	Yes	Yes
IEEE802.3u 100Base-TX/FX	TX	Yes
IEEE802.3x FDX 10/100Base-T	Yes	Yes
IEEE802.3x Flow Control 100Base-T	Yes	Yes
IEEE802.1d Spanning Tree	Yes 1	Yes
IEEE802.1p Prioritization	No	Yes
IEEE802.1Q VLAN	No 2	Yes
Auto-sensing 10/100	Yes	Yes
Link Aggregation	No	EtherChannel
3Com resilient links	Yes	No

	IBM 8271-712	Cisco 2924M XL
SNMP + RMON	Yes	Yes
HTML	Yes	Yes
ATM Uplink OC3 / OC12	OC3	OC3
UNI 3.0 / 3.1 / 4.0	3.0 / 3.1	3.0 / 3.1
FC LANE 1.0 / 2.0	1.0	1.0

1 No Spanning Tree support with ATM UFC.

2 Proprietary port-based VLAN.

Table 2. IBM 8271-E12/24

	IBM 8271-Exx	Cisco 2820
IEEE802.3 10Base-T	Yes 12/24	Yes 12/24
IEEE802.3 AUI	Yes	Yes
IEEE802.3u 100Base-TX/FX	Uplink	Yes
IEEE802.3z 1000Base-SX	Uplink	No
IEEE802.3x FDX 10/100Base-T	Yes	Yes
IEEE802.3x Flow Control 100Base-T	Yes	Yes
IEEE802.1d Spanning Tree	Yes	Yes
IEEE802.1p Prioritization	Yes	Yes
IEEE802.1Q VLAN	16	Yes
Auto-sensing 10/100	No	No
Link Aggregation	Yes 1	EtherChannel
3Com resilient links	No	No
Matrix Module (stacking)	Yes	No
SNMP + RMON	Yes	Yes
HTML	Yes	Yes

1 LAG/ EtherChannel.

Table 3. IBM 8271-F12/24

	IBM 8271-F12/24	Cisco 2924M XL
IEEE802.3 10Base-T	Yes	Yes
IEEE802.3u 100Base-TX/FX	Yes	Yes
IEEE802.3x FDX 10/100Base-T	Yes	Yes
IEEE802.3z 1000BaseSX	Uplink	Yes
IEEE802.3x Flow Control 100Base-T	Yes	Yes
IEEE802.1d Spanning Tree	Yes	Yes
IEEE802.1p Prioritization	Yes	No
IEEE802.1Q VLAN	16	Yes
Auto-sensing 10/100	Yes	Yes
Link Aggregation	Yes 1	EtherChannel
3Com resilient links	Yes	No
Matrix Module (stacking)	Yes	Clustering
SNMP + RMON	Yes	Yes
HTML	Yes	Yes

1 LAG/ EtherChannel.

Table 4. IBM 8274-W93 compared with Cisco

	IBM 8274-W93	Cisco
EtherChannel	* 1	* 1

1 The EtherChannel in IBM 8274 and Cisco is not compatible, even though both call it the same.

Table 5. IBM 8275-217/225 compared with Cisco 2924XL

	IBM 8275-217/225	Cisco 2924XL
IEEE802.3 10Base-T	16/24	Yes
IEEE802.3u 100Base-TX/FX	Uplink	Yes
IEEE802.3x FDX 10/100Base-T	Yes	Yes
IEEE802.3x Flow Control 100Base-T	Yes	Yes

	IBM 8275-217/225	Cisco 2924XL
IEEE802.1d Spanning Tree	Yes	Yes
IEEE802.1p Prioritization	No 1	No
IEEE802.1Q VLAN	Yes	Yes
Auto-sensing 10/100	Yes	Yes
Link Aggregation	Yes	EtherChannel
SNMP + RMON	Yes	Yes
HTML	Yes	Yes

1 802.1p Static Multicast filtering supported.

Table 6. 8271-324

	IBM 8275-324	Cisco 2924XL
IEEE802.3 10Base-T	Yes	Yes
IEEE802.3u 100Base-TX/FX	Yes	Yes
IEEE802.3xFDX 10/100Base-T	Yes	Yes
IEEE802.3xFlow Control 100Base-T	Yes	Yes
IEEE802.1d Spanning Tree	Yes	Yes
IEEE802.1p Prioritization	No	No
IEEE802.1Q VLAN	No	Yes
Auto-sensing 10/100	Yes	Yes
Link Aggregation	Yes	EtherChannel
SNMP + RMON	Yes	Yes
HTML	Yes	Yes

Table 7. IBM 8275-318/322/326 compared with Cisco 4003

	IBM 8275-3xx	Cisco 4003
IEEE802.3 10Base-T	Yes	Yes
IEEE802.3u 100Base-TX/FX	Yes	Yes
IEEE802.3x FDX 10/100Base-T	Yes	Yes

	IBM 8275-3xx	Cisco 4003
IEEE802.3x Flow Control 100Base-T	Yes	Yes
IEEE802.1d Spanning Tree	Yes	Yes
IEEE802.1p Prioritization	No	Yes
IEEE802.1Q VLAN	No 1	Yes
Auto-sensing 10/100	Yes	Yes
Gigabit Uplink	Yes	Yes
Link Aggregation	Yes	Yes
Port Mirroring	Yes	Yes
3Com resilient links	No	No
SNMP + RMON	Yes	Yes
HTML	Yes	Yes

8275-318 switches provide 16 100Base-FX ports + two optional expansion slots.

8275-322 switches provide 12 10/100Base-TX ports + eight 100BaseFX ports.

8275-326 switches provide 24 10/100Base-TX Ports.

1 Proprietary port-based VLAN supported.

Table 8. IBM 8275-412 compared with Cisco 2924XL

	IBM 8275-412	Cisco 2924XL
IEEE802.3 10Base-T	Yes	Yes
IEEE802.3u 100Base-TX/FX	Yes	Yes
IEEE802.3x FDX 10/100Base-T	Yes	Yes
IEEE802.3x Flow Control 100Base-T	Yes	Yes
IEEE802.1d Spanning Tree	Yes	Yes
IEEE802.1p Prioritization	Yes	No
IEEE802.1Q VLAN	Yes	Yes
Auto-sensing 10/100	Yes	Yes

	IBM 8275-412	Cisco 2924XL
Link Aggregation	Yes	EtherChannel
Port Mirroring	Yes	Yes
3Com resilient links	No	Yes
Self-Learning IP	Yes	No
SNMP + RMON	Yes	Yes
HTML	Yes	Yes

IBM 8275-412 Version 1.2 firmware supports self-learning IP.

Table 9. 8277-524 compared with Cisco 5505

	IBM 8277-524	Cisco 5505
IEEE802.3 10Base-T	Yes	Yes
IEEE802.3u 100Base-TX/FX	Yes 1	Yes
IEEE802.3x FDX 10/100Base-T	Yes	Yes
IEEE802.3x Flow Control 100Base-T	Yes	Yes
IEEE802.1d Spanning Tree	Yes	Yes
IEEE802.1p Prioritization	No	Yes
IEEE802.1Q VLAN	Yes	Yes
Auto-sensing 10/100	Yes	Yes
Link Aggregation	RouteChannel	EtherChannel
Layer-3 Switching	Yes	Yes
IP and IPX Routing	Yes	Yes
ICMP	Yes	Yes
OSPF	Yes	Yes
RIP II	Yes	Yes
NHRP	Yes	Yes
SNMP + RMON	Yes	Yes
HTML	Yes	No
ATM Uplink OC3 / OC12	OC3	OC3 / OC12

	IBM 8277-524	Cisco 5505
UNI 3.0 / 3.1 / 4.0	3.0 /3.1	3.0 / 3.1
FC LANE 1.0 / 2.0	1.0	1.0 / 2.0
RFC1577 CIP	Yes	Yes
RFC1483 MPOA	Yes	Yes

1 100Base-FX uplink

Table 10. IBM 8371-A16 compared to Cisco 5505

	IBM 8371-A16	Cisco 5505
IEEE802.3 10Base-T	Yes	Yes
IEEE802.3u 100Base-TX/FX	Yes	Yes
IEEE802.3x FDX 10/100Base-T	Yes	Yes
IEEE802.3x Flow Control 100Base-T	Yes	Yes
IEEE802.1d Spanning Tree	Yes	Yes
IEEE802.1p Prioritization	Yes	Yes
IEEE802.1Q VLAN	Yes	Yes
Auto-sensing 10/100	Yes	Yes
Link Aggregation	Yes - LAG	EtherChannel
Layer-3 Switching	Yes	Yes
IP and IPX Routing	Yes	Yes
Self-Learning IP	Yes	No
OSPF	Yes	Yes
RIP	Yes	Yes
BGP-4	Yes	Yes
NHRP	Yes	Yes
SNMP + RMON	Yes	Yes
HTML	Yes	No
ATM Uplink OC3 / OC12	Yes	Yes
UNI 3.0 / 3.1 / 4.0	3.0 / 3.1 / 4.0	3.0 / 3.1

	IBM 8371-A16	Cisco 5505
FC LANE 1.0 / 2.0	1.0 / 2.0	1.0 / 2.0
RFC1577 CIP	Yes	Yes
RFC1483 MPOA	Yes	Yes

IBM 8371 R2.0 supports four Link Aggregation Group (LAG) instances, with up to 10 physical Ethernet links in a LAG. The LAG function is not supported for ATM links. However, the LAG function is supported in conjunction with all of the layer-3 capabilities (routing, self-learning IP, MPC Client).The LAG implementation is interoperable with both Sun Microsystem's Sun Trunking 1.0 and Cisco's Fast EtherChannel Phase I, and interoperates with several models of IBM's 8275 Ethernet switching family.

2.2 ATM switches

In this redbook we consider IBM 8265 Nways ATM switch and the associated IBM 8210 Multiprotocol Switch Server for interoperability with Cisco's ATM and Ethernet solutions.

Today, as a result of IBM's strong investment in the development of ATM technology and products, many customers operate large IBM 8265 networks and make use of many advanced functions.

The best strategy for extending and eventually migrating a large IBM 8265 LAN is most likely a gradual build-up of an overlay network, and almost inevitably this network will be based on Ethernet technology.

A few years ago ATM cell switching was the only technology that seemed to give a solution to the emerging requirement for managing bandwidth with Quality of Service and prioritization and to the increasing concern over security. And in addition, ATM was strongly founded on standards.

Advances in microelectronics and pioneering enhancements of Ethernet technology, buoyed by the enormous market acceptance of Ethernet, have changed this picture dramatically.

Overall, ATM was the best technology to integrate diverse protocols and interfaces for such purposes as sharing bandwidth between transport of data and voice. But new products are rapidly becoming available based on frame switching and the switched Gigabit Ethernet interface.

For these reasons, our general recommendation for a long-term strategy is to migrate the ATM LAN backbone to an Ethernet backbone. The periphery of an IBM 8265 backbone is frequently a mixture of Ethernet and token-ring because ATM and advanced LAN emulation were excellent technologies to provide a high-speed backbone for both of these media access technologies as well as to provide for integration between them.

All of this amounts to a general recommendation to build a parallel or overlay Ethernet backbone to secure an orderly migration. In the process of doing so, we may take advantage of functions such as MPOA for IP and IPX and of the high performance of the MSS to bridge non-routable protocols. This is advantageous because we need a high bandwidth connection between the two backbones during the transition. In Chapter 4, “ATM LAN backbone interoperability and migration” on page 67 we will discuss a scenario for ATM LAN migration in more detail.

The most likely candidate to complement and eventually replace the IBM 8265 switch is Cisco Catalyst 6500. However, if there is a specific, continuing requirement for ATM interfaces and cell switching, Catalyst 8540 provides an excellent combination of both ATM and Gigabit Ethernet technologies.

2.2.1 Criteria for comparison

Major functions to consider for interoperability are:

- Interfaces
- Interface signalling
- Call routing, PNNI
- Traffic management
- LAN emulation services
- Layer-3 services

2.2.1.1 Interfaces

The common interfaces for the LAN environment such as OC-3 and OC-12 are readily supported by most manufacturers of ATM LAN switches for UTP wiring or multi-mode or single mode fiber, or interface converters are generally available.

ATM-25 is still in use by some customers, but because it did not gain wide market acceptance, this technology is being phased out by most vendors. IBM has withdrawn most of its ATM-25 products from marketing. To investigate a migration strategy, IBM Global Services contacts for your country are found at `http://www.ibm.com/planetwide`.

For connection to a WAN, IBM 8265 supports many common standards-based interfaces such as:

- E1,DS1 and J1
- E3 and DS3
- OC-3/STM-1 with SONET or SDH STM-1
- Inverse multiplexing of E1 or DS1 (IMA)

2.2.1.2 Interface signalling

If it is desirable to add a backbone or workgroup switch of another brand to a network of IBM 8265 switches, customers must know which interface signalling they need support for. All three user-to-network interface protocols currently standardized are supported by most equipment on the market:

- UNI 3.0
- UNI 3.1
- UNI 4.0

In addition IBM 8265 supports automatic recognition and interworking (with some limitations) between these three standards. This may have a value for the user, but lack thereof can be worked around.

ILMI is supported on most ATM switches. In addition, IBM 8265 provides for an access control feature that gives some protection against unauthorized access to a port.

Public ATM networks in general do not provide switched virtual circuits, but rather a permanent virtual path between customer equipment. When such an interface is defined as void on the IBM 8265, multiple virtual path channels (VPC) are supported. A VPC can operate in UNI mode, IISP mode, or PNNI mode, or with no signalling at all. This works well for supporting all kinds of signalling across an ATM WAN between IBM 8265 switches and user stations.

To migrate to a Cisco switch environment some network re-design may be required, usually involving the ATM PVC being used as a high-speed point-to-point connection between routers.

2.2.1.3 Call routing

PNNI is supported by IBM and Cisco Systems. The Catalyst and Lightstream ATM switches support full PNNI hierarchy like IBM 8265.

2.2.1.4 Traffic management

IBM and Cisco ATM switches generally support all classes of service:

- Available bit rate (ABR)

- Constant bit rate (CBR)
- Unspecified bit rate (UBR)
- Variable bit rate (VBR)

In the case of IBM 8265, VBR is supported as CBR.

Traffic shaping and policing is required when interconnecting ATM switches over a public carrier where the contracted quality of service is less that the physical speed of the connection.

2.2.1.5 LAN emulation services

The basic LAN emulation functions provided by an ATM backbone comprise:

- LAN emulation configuration server (LECS)
- LAN emulation server (LES)
- Broadcast and unknown server (BUS)

LECS/LES/BUS are the basic functions provided by IBM 8210 Multiprotocol Switch Server (MSS). For small networks a LES/BUS integrated in the IBM 8265 Control Point is sometimes used to avoid the cost of an MSS.

LECS/LES/BUS are functions that are critical to the operation of an ATM LAN, and therefore various schemes are implemented to provide redundancy. These schemes are fairly complex, and it is not recommended that LECS/LES/BUS servers of different brands be deployed for redundancy.

LAN emulation is based on strong standards. Other than for the complexity of redundant operation of LECS/LES/BUS, LAN emulation is generally interoperable between different vendor equipment.

Cisco Systems provides several implementations of the LECS/LES/BUS function, for example in high-end IOS products such as Cisco 7200 and on layer-3 modules for some Catalyst switches. In the case of the OC-12 LANE module for Catalyst 6500, a complete LANE server implementation is provided. For most purposes a Cisco 7200 IOS router with a single OC-3 ATM interface can be equated to an IBM 8210 MSS.

2.2.1.6 Layer-3 services

Since ATM technology lends itself to innovations in the area of layer-3 routing, it is desirable to closely integrate these with the layer-2 hardware. For this reason the MSS provides such functions together with support for a comprehensive set of traditional routing protocols. As mentioned, Cisco IOS provides almost the same functionality as the MSS.

NHRP and MPOA

The Next Hop Resolution Protocol (NHRP) and Multiprotocol over ATM (MPOA) are extensions of LAN emulation to layer 3.

Cisco IOS provides support for NHRP and MPOA, client as well as server. Clients are supported on most router and switch products with an ATM uplink. Only IP is supported by Cisco's MPOA implementations, whereas IBM products support both IP and IPX.

This means that IPX traffic cannot be shortcut routed between Cisco MPOA clients. It may still be routed to and from a Cisco LEC by the MSS or a Cisco router. Alternatively, IPX traffic can be bridged, just as nonroutable traffic can be bridged by MSS or Cisco router. Both the IBM and Cisco products support transparent, source-route, and translational bridging.

Classical IP and multi-protocol encapsulation

Classical IP (RFC 1577) connects ATM user stations employing IP. In principle the user stations themselves provide all the layer-3 connectivity functions. However, MSS is often used as an ARP server or as a bridge to emulated LAN segments. Cisco IOS provides the same functions.

Multi-protocol encapsulation (RFC 1483) connects ATM user stations employing IP and IPX as well as nonroutable protocols. Both MSS and Cisco can bridge between RFC 1483 stations and stations on other logical or physical interfaces.

SNA support

MSS and Cisco IOS support equivalent sets of Data Link Switching (DLSw). There are some differences in the APPN support provided by MSS and Cisco IOS. If you need to migrate an MSS in an APPN network, IBM Global Services contacts for your country are found at `http://www.ibm.com/planetwide`. This migration is beyond the scope of this redbook.

Super VLAN, shortcut bridging, and broadcast management

Though fully based on international and industry standards, these functions are IBM proprietary and therefore do not interoperate with Cisco's implementations.

This does not prevent you from continuing to use these or any other MSS functions in a mixed network. We have seen that Cisco's implementation of MPOA clients work very well with the MPOA server in MSS. You may also continue to use MSS for dynamic protocol filtering, but do not attempt to use it

together with a similar function such as the broadcast limitation supported by the layer-3 engines of some Catalyst switches.

2.2.2 Comparison of IBM 8265-17A with Cisco 8540

Table 11. IBM 8265-A17 compared to Cisco 8540

	IBM 8265-17A	Cisco 8540
Redundant switching blade	Yes	Yes
OC-3	Yes	Yes
OC-12	Yes	Yes
WAN T1/E1 to OC-3/ STM-1	Yes	Yes
T1/E1 IMA	Yes	Yes
Frame Relay FRAIM	Yes	Yes
Circuit Emulation	Yes	Yes
ESCON	Yes	No
IISP	Yes	Yes
PNNI-1	Yes	Yes
UNI 3.0 / 3.1 / 4.0	Yes	Yes
VOID / Public Uni	Yes	Yes
E.164	Yes	Yes
LES	Yes	Yes
100Base-TX/FX	Yes	Yes
LECS	Yes	Yes
LES/BUS	Yes	Yes
RFC1577 CIP	Yes	Yes
MPOA Client	Yes	Yes
VLAN	Yes	Yes
MPOA Server	Yes	Yes
SNMP	Yes	Yes
HTML	Yes	No

2.2.3 Comparison of IBM 8210 MSS Server with Cisco 7200

Table 12. IBM 8210 / MSS Blade compared with Cisco 7200

	IBM 8210	Cisco 7200
LECS/LES/BUS	Yes	Yes
ELAN - token-ring/ Ethernet	Yes	Yes
Redundant LES/BUS	Yes	SSRP 1
Classical IP (RFC1577)	Yes	Yes
ARP Server	Yes	Yes
NHRP Server	Yes	Yes
MPOA Server	Yes	Yes
Multiprotocol Encapsulation (RFC 1483)	Yes	Yes
APPN	Yes	Yes
DLSw	Yes	Yes
RIP/ OSPF/ BGP	Yes	Yes
Bridging SRB/TB/SRTB	Yes	Yes
FDDI-to-ATM	Yes	Yes
Super VLAN	Yes	No
Shortcut Bridging	Yes	No
Intelligent Broadcast Manager	Yes	No
Dynamic Protocol Filtering	Yes	No

1 SSRP (Simple Server Redundancy Protocol) is a Cisco redundant LANE protocol.

Other Cisco devices, such as the 8540, have the possibility of supporting part or all of the MSS functionality, depending on which modules are installed.

Chapter 3. Ethernet switch interoperability

In this chapter we consider a basic, flat layer-2 switched Ethernet LAN. In the previous chapter we went through several of the characteristics of Ethernet switches that we should consider for interoperability in this environment.

The size of a flat layer-2 Ethernet LAN is usually limited by the broadcast activity to a few hundred MAC addresses, but single broadcast domains of several thousand have been heard of.

Joining several layer-2 domains in installations with Ethernet switches from IBM has traditionally been accomplished with classical layer-3 routers such as IBM 2216, or the IBM 8274 RouteSwitch, or through an ATM backbone with the Multiprotocol Switched Services (MSS) server. Interoperability of traditional layer-3 routers is the subject of a recently published redbook *IBM Router Interoperability and Migration Examples*, SG24-5865. The employment of ATM and the MSS is discussed in Chapter 4, “ATM LAN backbone interoperability and migration” on page 67.

In this redbook we do not consider in detail the layer-3 and layer-4 functions of the IBM 8371 switch since these are not widely deployed, having been available only after the IBM-Cisco alliance was announced.

In “Scenario 1: Single subnet - step-by-step box addition” on page 25 and “Scenario 2: Multiple subnets - growth environment” on page 26, we discuss two generalized scenarios. In “Basic Ethernet interoperability exercises” on page 27 we describe in some detail two interoperability laboratory exercises that we performed, and we discuss our experiences.

Please contact your IBM or Cisco representative to get the latest information about the interoperability tests performed jointly by IBM and Cisco, and for instructions on submitting requests for new interoperability tests.

3.1 Scenario 1: Single subnet - step-by-step box addition

This scenario describes the case where we have an Ethernet LAN with a single broadcast domain. The backbone is a single or a few switches, for instance IBM 8271. Workstations are often on shared segments made up of hubs such as IBM 8237.

Generally you find this type of LAN in small businesses or in branch offices. There is no immediate demand for new functions or significantly increased performance. Workstations often run at 10 Mbps, but there is a general trend

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to move them to fast Ethernet and switched ports, mostly because it is feasible and not very costly.

3.2 Scenario 2: Multiple subnets - growth environment

In this generalized scenario the installation in question is in a growth environment and the owning organization is pursuing a strategy to implement advanced functions such as multimedia and telephony. Additionally, bandwidth requirements may be expected to grow considerably.

This is an obvious case for implementing VLANs and a more powerful backbone switch with layer-3 and 4 function to classify data flows and enforce service policies.

In this environment we want to gradually build a VLAN-based network. We recommend that the VLAN be based on the IEEE 802.1Q standard. Most Cisco Catalyst switches support this standard as well as the ISL protocol. For more information about products that support IEEE 802.1Q refer to the redbook *Application-Driven Networking: Class of Service in IP, Ethernet and ATM Networks, SG24-5384-00.*

Note

Inter-Switch Link, ISL protocol, is not supported by any IBM boxes. It is a Cisco proprietary protocol.

Interoperability and coexistence of IBM and Cisco hubs and switches in this environment are quite feasible. Not all IBM switches support port-based 802.1Q VLAN, but if several workstations attached in a wiring closet belong to the same VLAN, they might as well share the same switch or hub.

Of course, this may impede campus-wide VLANs. However, while large, flat campus-wide VLANs have their advantages, there are also many potential pitfalls. A potential source of problems in such a network is the time required and possible instability of the spanning tree protocol (STP) to converge. Today, backbone switches handle millions of packets per second on layers 3 and 4 at a reasonable cost. It is probably a healthier design to localize VLAN with respect to resources (such as servers), and geography (such as wiring closets or buildings) and leave access control and policy to the backbone switch.

3.3 Basic Ethernet interoperability exercises

In the following sections we describe our experiences during two test scenarios, and we show the configuration process in detail. The two scenarios are:

1. Port trunking or EtherChannel interoperability
2. IEEE 802.1Q VLAN interoperability

We were left with the general impression that interoperability between the IBM and Cisco switches we sampled worked very well, in fact over expectation. In Chapter 2, “Functional comparisons” on page 7 we discussed how two proprietary protocols, port trunking and EtherChannel, can interoperate.

It also seemed as if an internal improvement made by Cisco Systems to the spanning tree protocol worked even when the Cisco switch was connected to an IBM switch. The benefit was that STP reconfiguration only took a few seconds. However, we did not investigate this in detail.

3.3.1 Lab 1: Trunking IBM 8275-322 and Cisco 2924-XL

3.3.1.1 Setup for Lab 1

In this test we will connect two Ethernet switches via a trunk (EtherChannel).

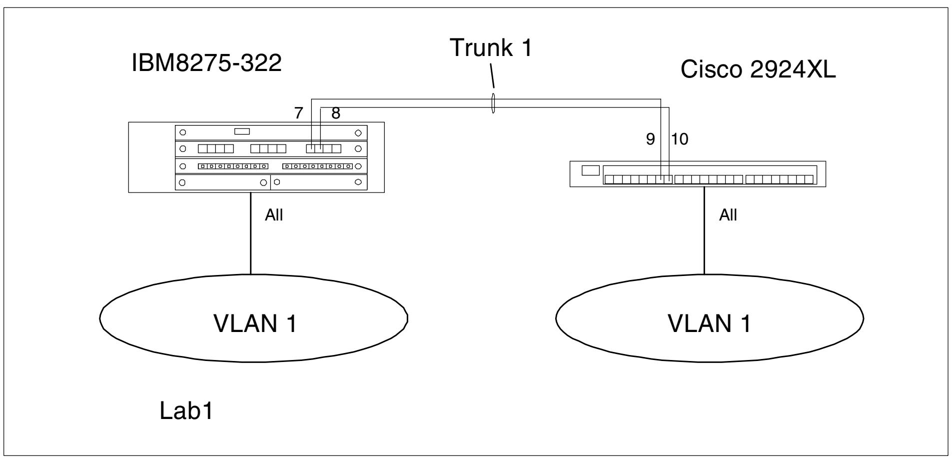

Figure 6. Lab 1, connections

Figure 6 shows the physical connections for this test. All ports on the two switches will be in the same VLAN, VLAN 1 (the default VLAN), and the two switches will be interconnected via a trunk of two FastEthernet connections,

with a total capacity of 400 Mbps full duplex (100x2x2). The simplicity of this test is shadowed by the fact that the IBM 8275-322 does not support IEEE 802.1Q trunking nor Cisco's ISL protocol.

3.3.1.2 Configuring the IBM 8275-322 Switch

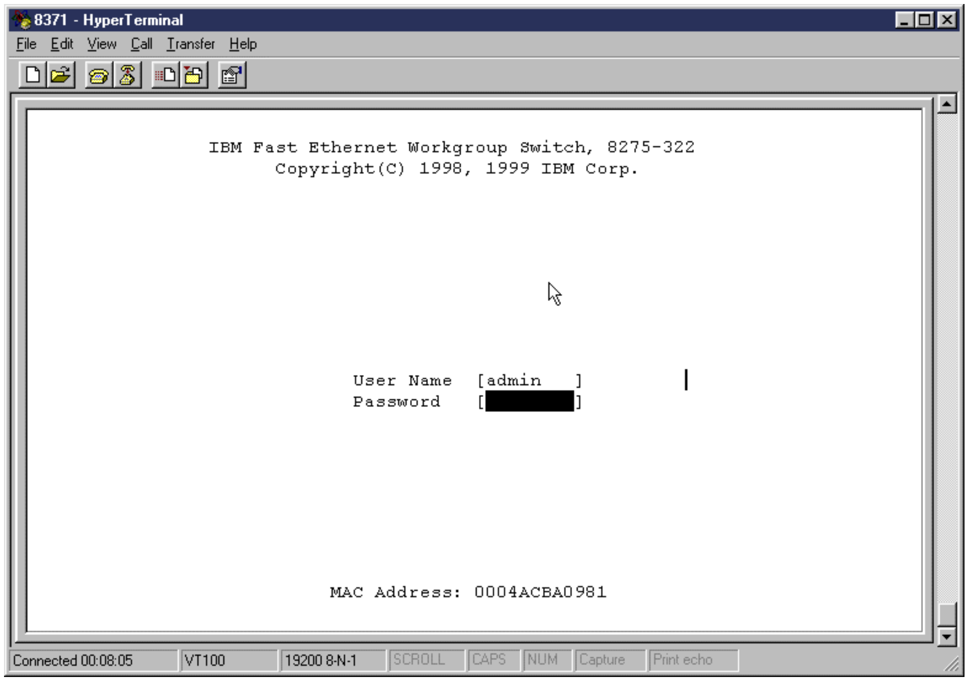

Figure 7. Logon screen to IBM 8275-322 Switch

We begin this test with connecting a terminal to the service port on the IBM 8275-322 Switch. The purpose is to do the IP configuration so we can access the switch from a Web browser. Default user name is `admin` and there is no password.

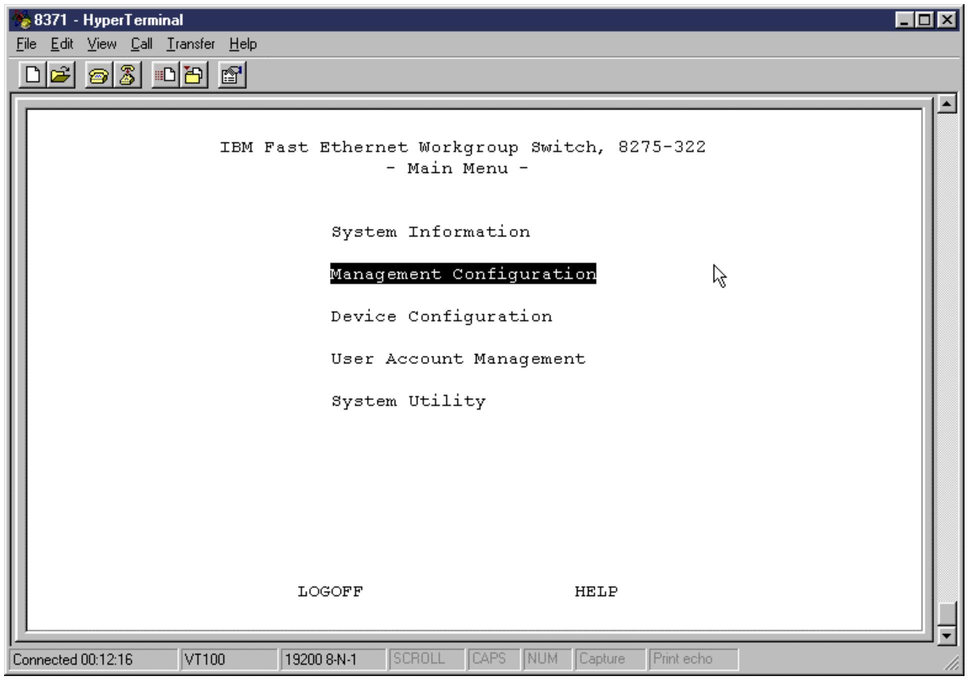

Figure 8. The 8275-322 Main Menu

From the Main Menu, we choose **Management Configuration** to get access to the Networking Configuration menu. We have the options to configure Network Configuration, Trap Receiver Configuration and SNMP Community Configuration. But at this point in time we only need to set up IP parameters, so we choose **Networking Configuration** from the menu.

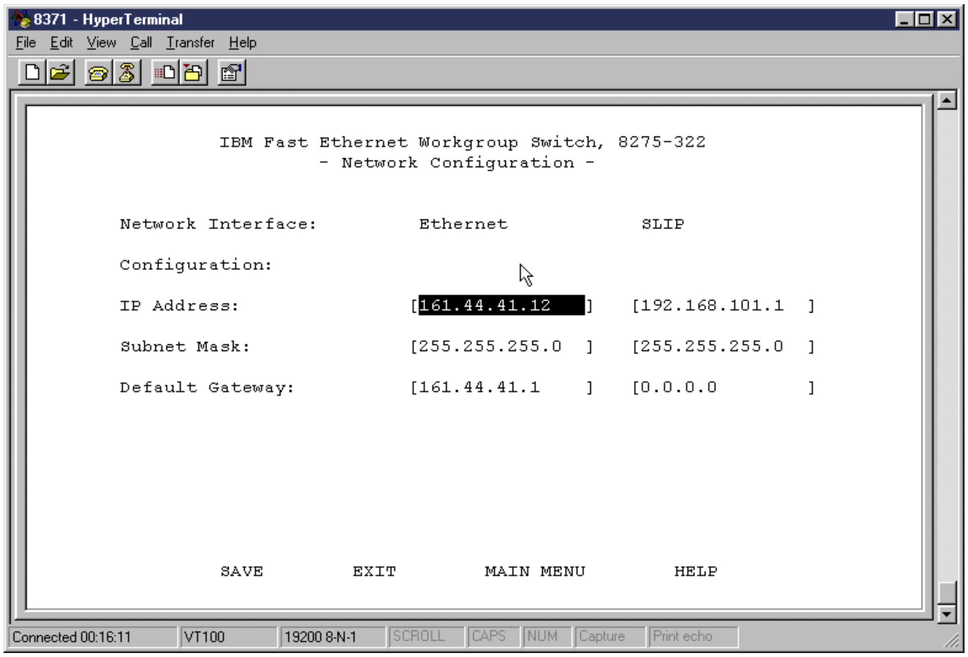

Figure 9. Network Configuration

From the Networking Configuration menu, we add the IP address, Subnet Mask and Default Gateway for the Ethernet LAN interface. We do not need to set up the SLIP parameters for this test.

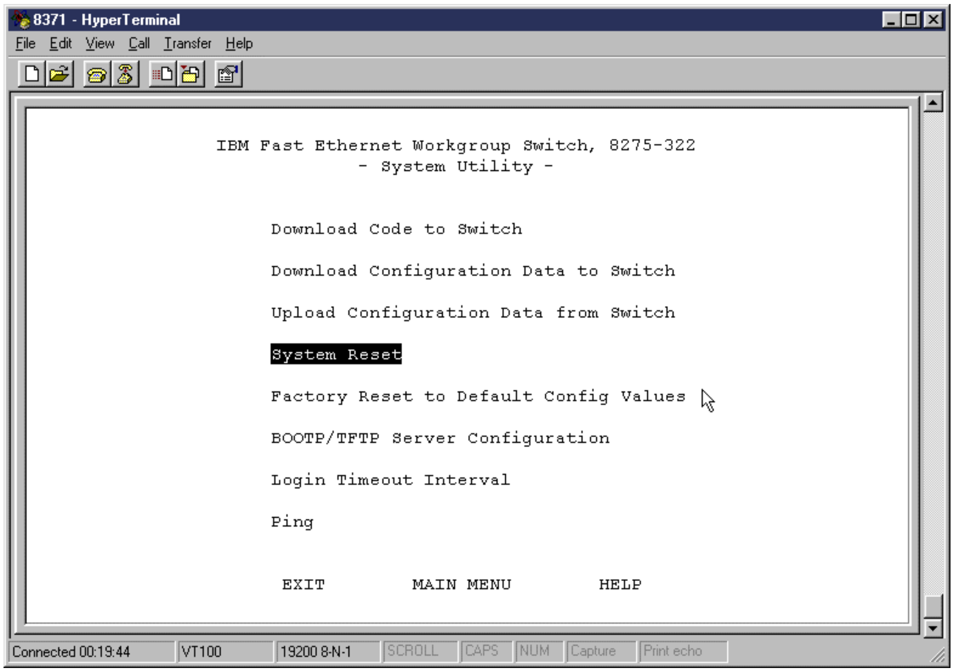

Figure 10. System Reset

Now we move back through the menus to the Main Menu and choose **System Utility -> System Reset** to activate our new IP configuration.

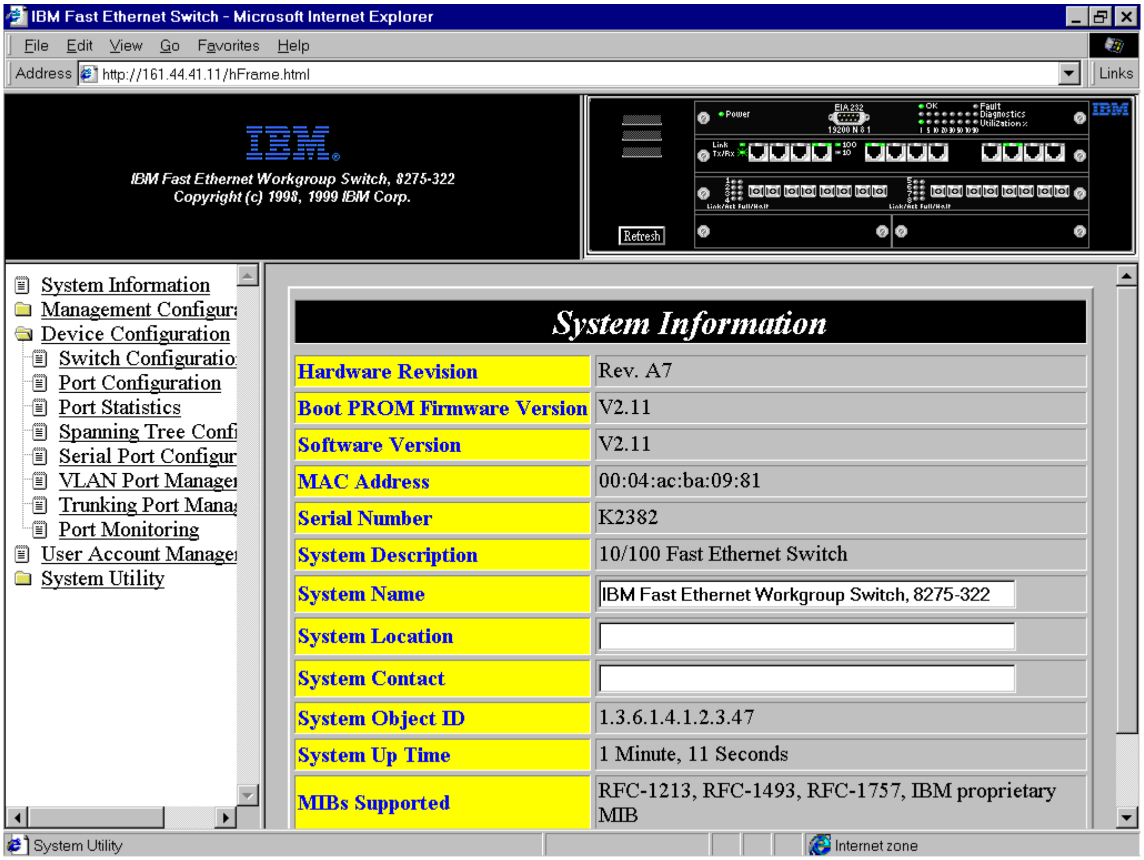

Figure 11. Web access to the IBM 8275-322

With our browser, in this case Microsoft Internet Explorer, we access the switch through its new IP address, 161.44.41.11, and after login we see Figure 11. At the top of the window, there is a picture of the switch, with color status on ports etc. In the right pane we have the worksheet, and to the left the navigation tree. We choose **System Information** at the top of the tree,and we can see such information as hardware revision, software version and system description.

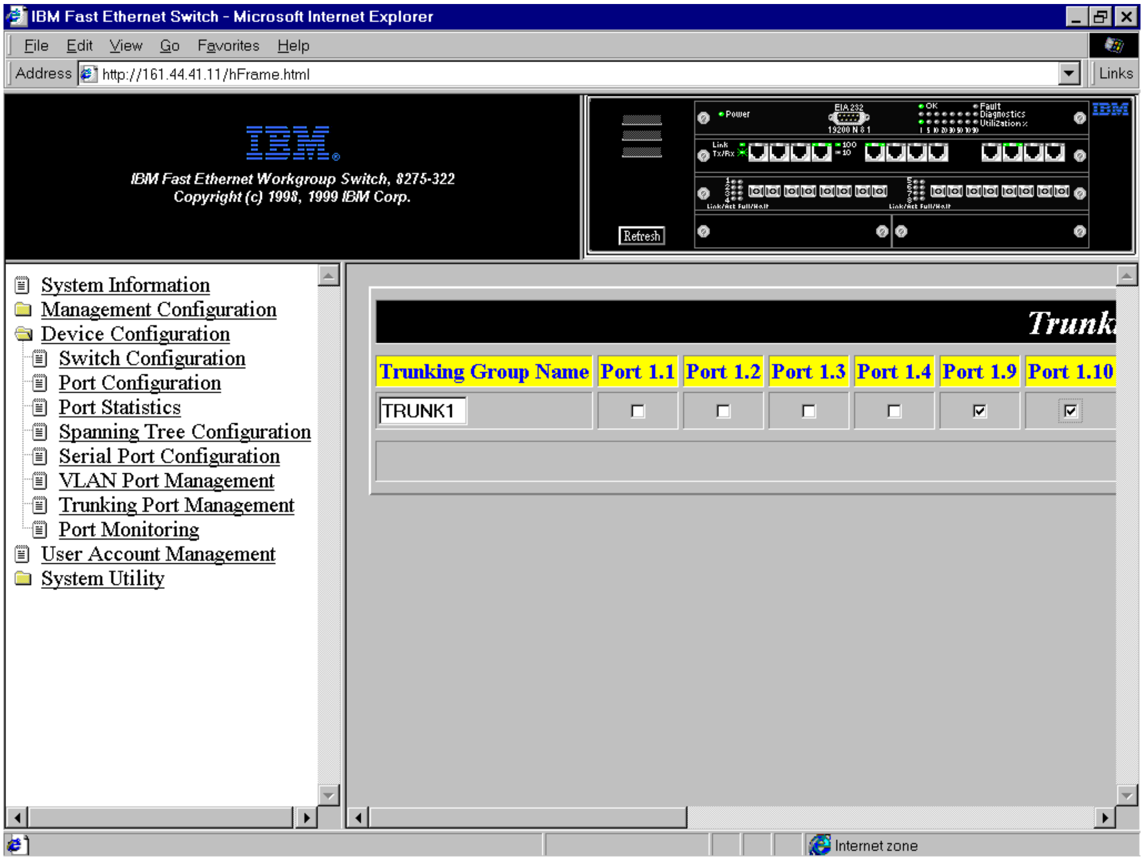

Figure 12. Trunk Config

From the navigation tree, we choose **Trunking Port Management,** to set up **TRUNK1**, and add ports 1.9 and 1.10 to the trunk as shown in Figure 12. The 8275-322 switch does not support trunking on ports 1.5, 1.6, 1.7 and 1.8.

As all the ports are on the same VLAN, we can use the default configuration. The recommendation for interconnection switches is to set the ports to fixed values. Auto negotiation allows the port to match the speed and duplex setting of the device to which it is connected. If you want to leave the ports in both switches in their default mode, AUTO for speed and duplex, remember that on some rare occasions the switches may not negotiate the best or fastest connection. We do not change the default settings for this test to see if the switches will negotiate the best connection parameters. Some switches do not advertise the duplex mode if their speed is fixed. In a situation where

the first switch is set to fixed 10Mbps half duplex and the second switch is set to auto, the second switch may be automatically set to 10Mbps full duplex.

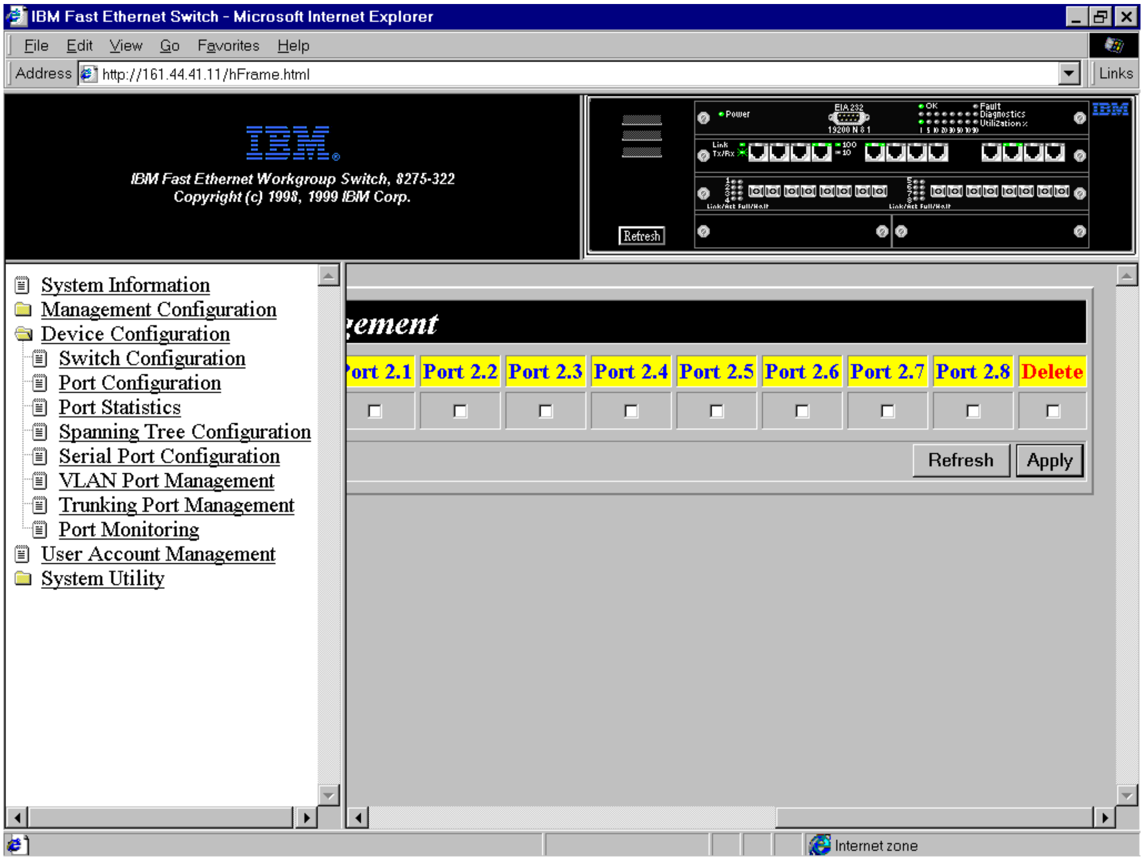

Figure 13. Save the changes in trunk definitions

At the bottom of the worksheet shown in Figure 13, we use the horizontal scroll bar to go to the far right of the Trunk Port Management window, where we can click the **Apply** button to save the changes we just made to port 1.9 and 1.10.

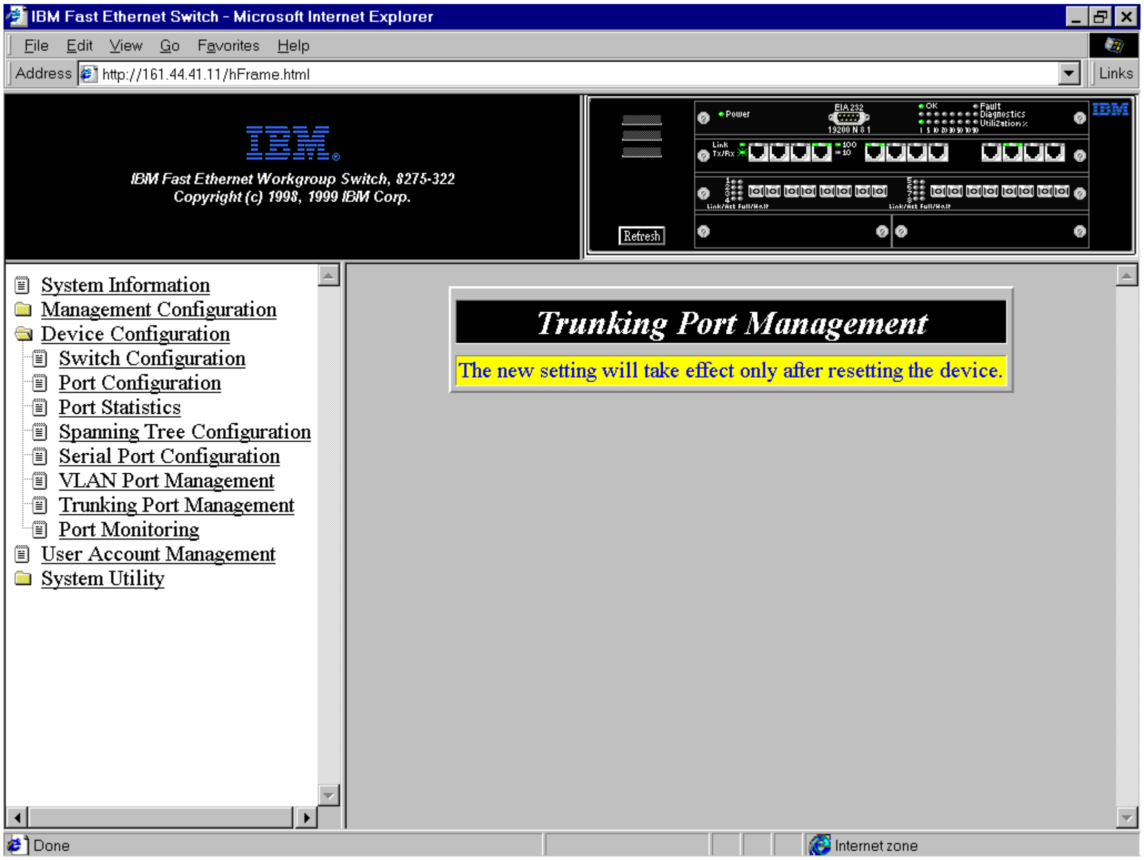

Figure 14. Trunking Port Management

We will need to reset the switch before the changes in configuration will take effect (Figure 14). To perform a reset, we choose **System Reset** from the System Utility menu in the navigation tree shown in Figure 15 on page 36. Click the **Apply** button at the right, and the reset will take place. This is the end of performing the configuration of the IBM 8275-322 switch. Now we have all the ports in the same domain (or VLAN), and have port 1.9 and 1.10 set up for trunking to be connected to the Cisco switch.

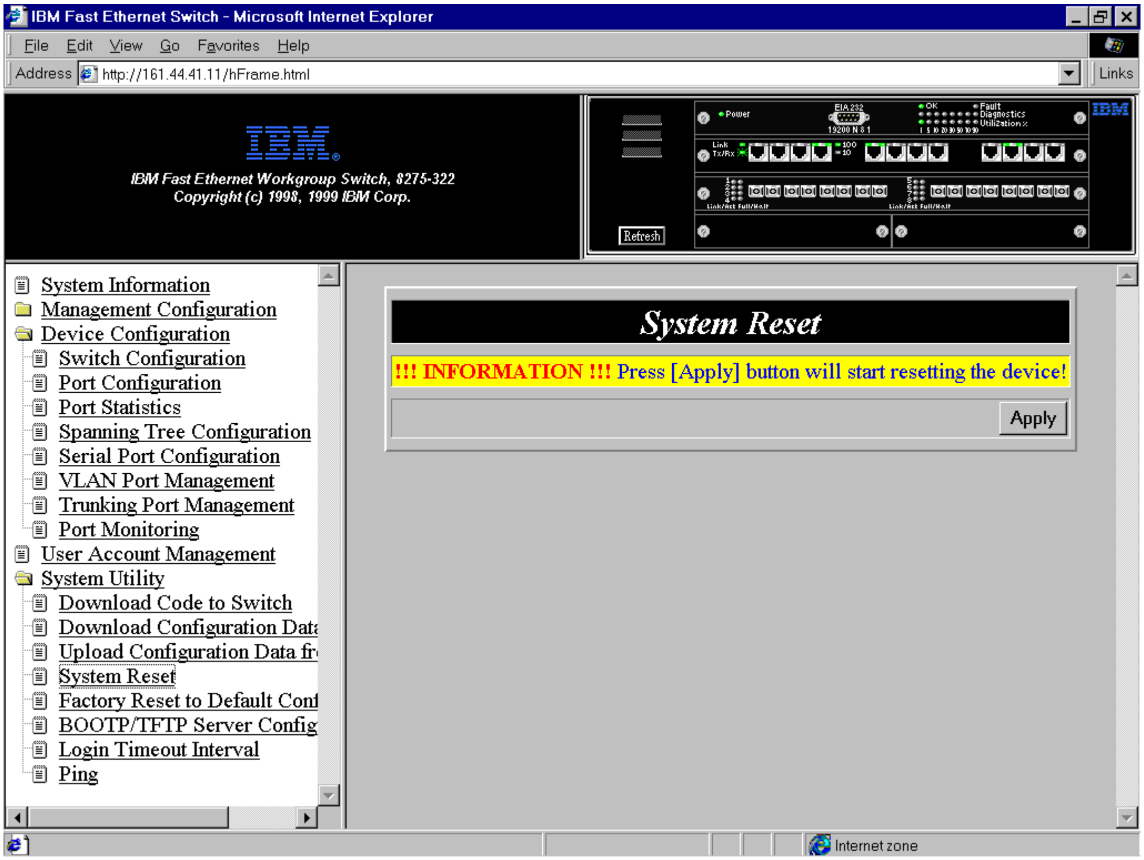

Figure 15. 8275-322 System Reset

3.3.1.3 Cisco 2924-XL configuration

Now we go to the configuration of the Cisco 2924-XL Switch. As we intend to use the Web interface and run the configuration from our browser, we need to set up an IP address to access the switch. That can be done in several ways, but the easiest way is to use the Setup Program. We need to connect a terminal or emulator to the console port. The default is 9600 baud, 8 data bit, 1 stop bit and no parity. Connecting to the terminal we will see the System Configuration Dialog.

```
     --- System Configuration Dialog ---

At any point you may enter a question mark '?' for help.
Use ctrl-c to abort configuration dialog at any prompt.
Default settings are in square brackets '[]'.

Continue with configuration dialog? [yes/no]: yes
Enter IP address: 161.44.41.12
Enter IP netmask: 255.255.255.0
Would you like to enter a default gateway address? [yes]: yes
IP address of default gateway: 161.44.41.1
Enter host name [Switch]: C2924-XL

The enable secret is a one-way cryptographic secret used
instead of the enable password when it exists.

Enter enable secret: cisco

The following configuration command script was created:

interface VLAN1
ip address 161.44.41.11 255.255.255.0
ip default-gateway 161.44.41.1
hostname C2924-XL
enable secret 5 $1$Ta8v$IuVrRYEuXGHChBfqyXFKT1
snmp community private rw
snmp community public ro
!
end

Use this configuration? [yes/no]: yes
Building configuration...
[OK]

C2924-XL>
```

Figure 16. System Configuration Dialog

We start with setting up an IP address, netmask, default gateway, host name and a secret password, to be used when we later enter the Privileged mode for further configuration.

When we are finished with the Setup Program, we need to enable support for telnet and HTTP server, and increase the numbers of simultaneous sessions. We must write the configuration to NVRAM.

All the commands we issued took effect immediately (Figure 17 on page 38). The `Write memory` command made sure that the changes were saved for the future reload of the switch.

```
C2924-XL>enable
Password:

C2924-XL#config terminal

C2924-XL(config)#line vty 0 6

C2924-XL(config)#ip telnet

C2924-XL(config)#ip http server

C2924-XL(config)#exit

C2924-XL#write memory
Building configuration...
[OK]

C2924-XL#
```

Figure 17. Config telnet and http support

Now we access the switch with our Web browser on IP 161.44.41.12, by typing `http://161.44.41.12` to the Address line of the browser (Figure 18 on page 39).

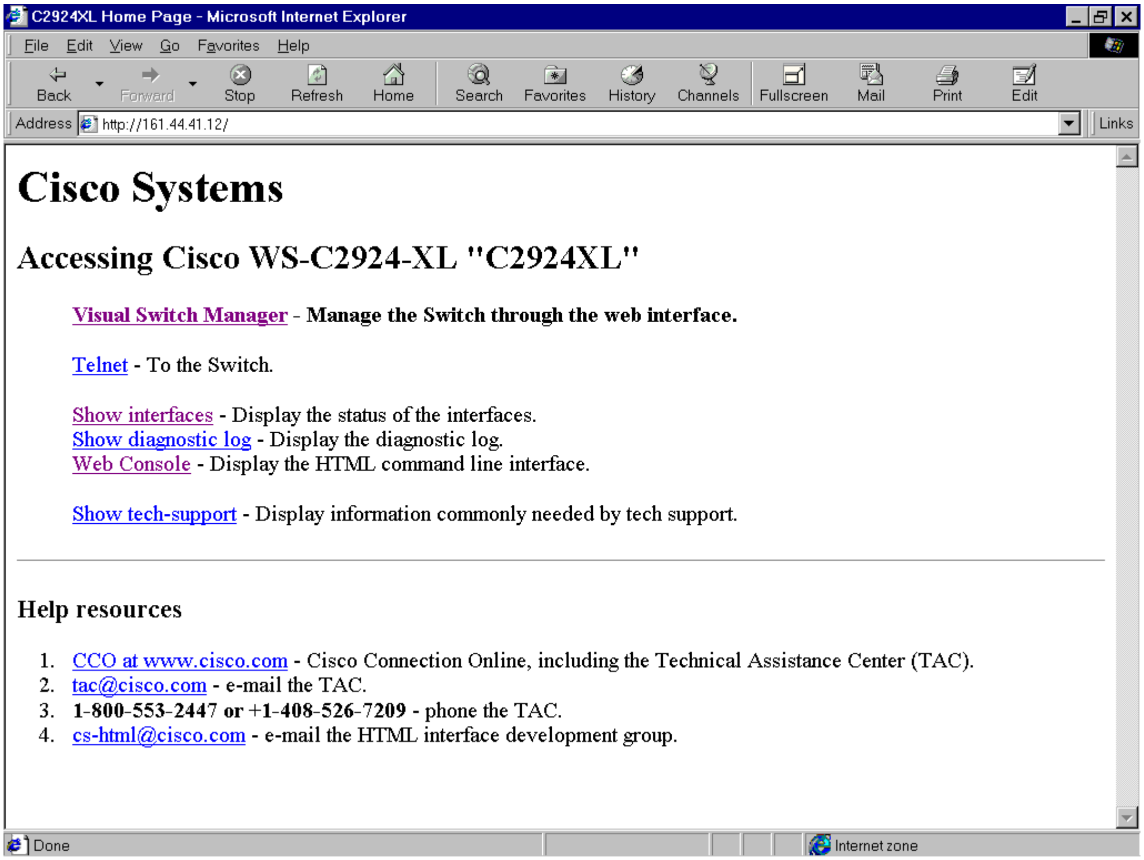

Figure 18. Cisco System Access Page

From the System Access Page in Figure 18, we choose **Visual Switch Manager** to manage the switch through the Web interface. This interface is only applicable to a subset of Cisco's smaller switches, but is becoming more common. For further information about the CVSM interface and functionality, see the *Cisco IOS Desktop Switching Software Configuration Guide*, or Cisco's Web site at `http://www.cisco.com`. The same Web site or product documentation can also be used to find out about product-specific requirements for the Web browser used in configuration.

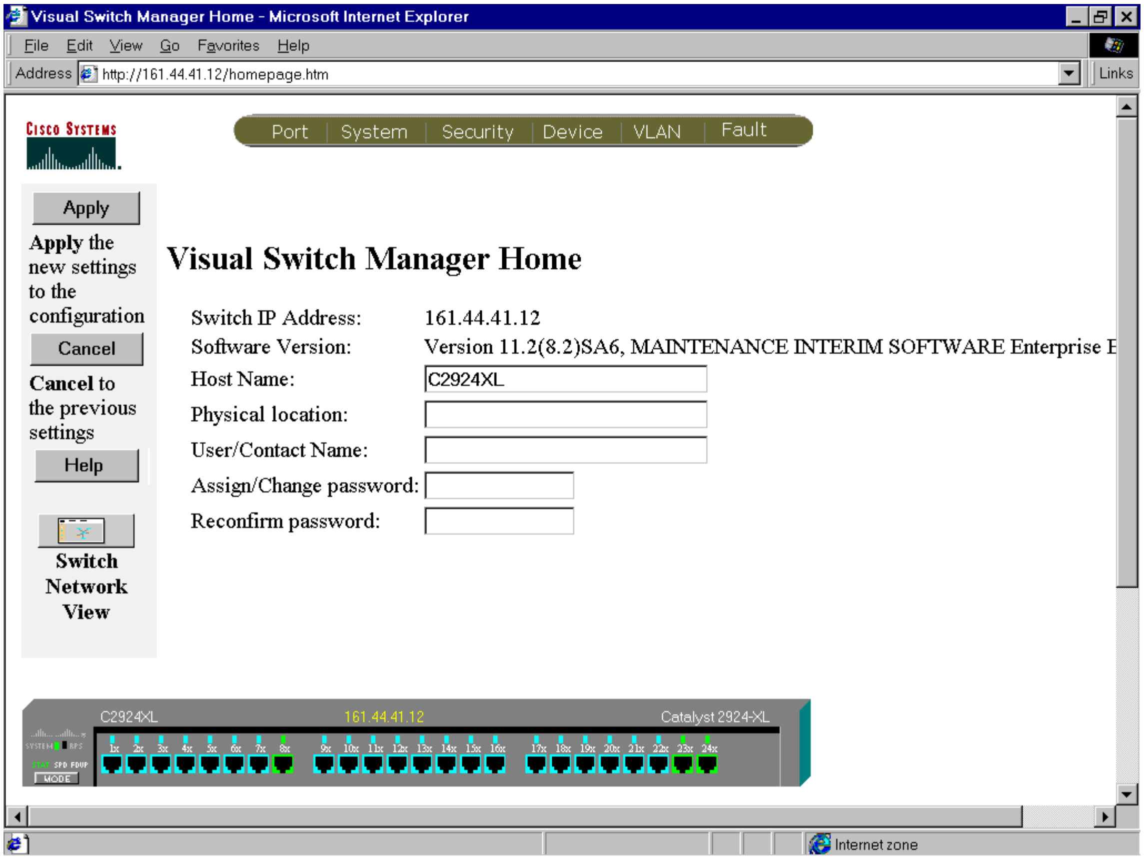

Figure 19. Visual Switch Manager Home

The Cisco Visual Switch Manager (CVSM) menu bar is located at the top of the Web page (Figure 19). From here, you can choose to configure Port, System, Security, Device, VLAN, and Fault.

We will look at the port configuration, port grouping, and VLAN management.

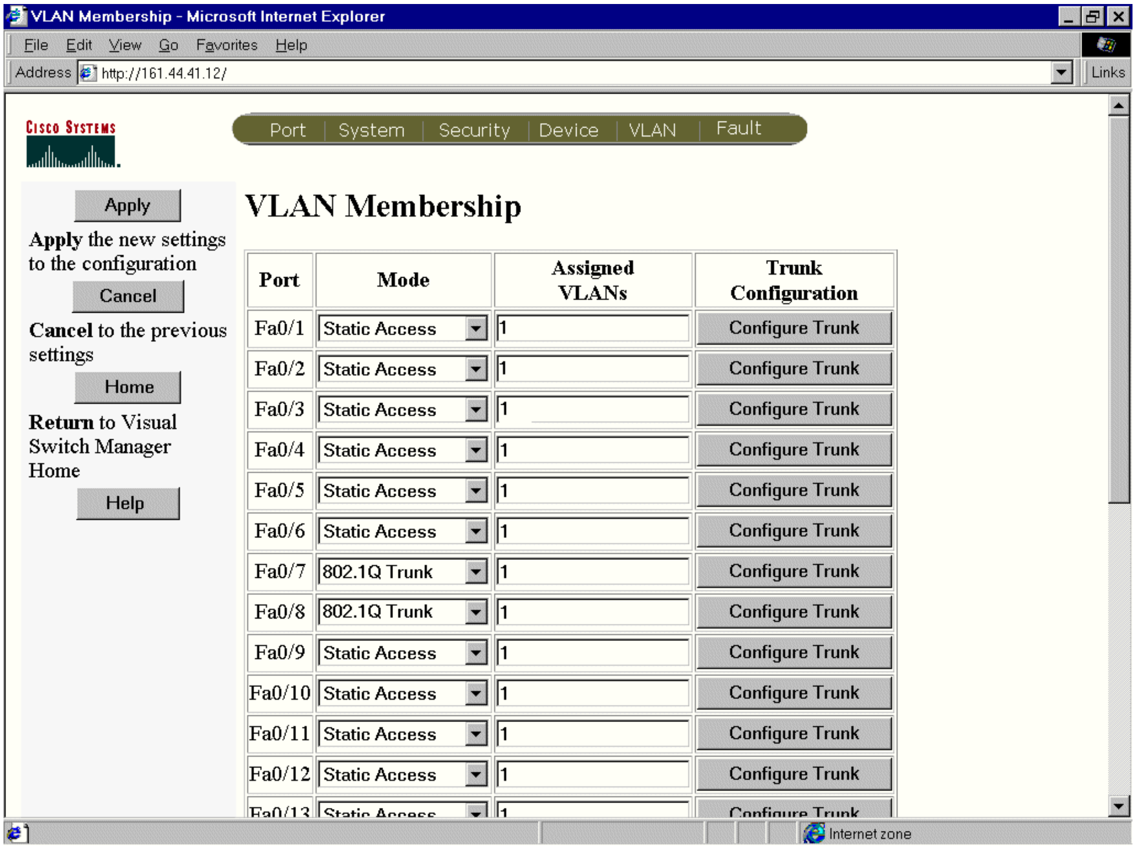

Figure 20. VLAN Membership page

Click **VLAN**, and we enter the VLAN Membership page (Figure 20). All ports are assigned to the same VLAN, “VLAN1”, as default. In this test we leave all ports in that VLAN, but change the mode for port Fa0/7 and Fa0/8 from Static Access to 802.1Q Trunk to enable trunking. Static Access ports belong to one VLAN. Trunk Ports can belong to multiple VLANs. Even though the IBM 8275-322 does not support the 802.1Q standard, we need to set up the Cisco 2924XL as 802.1Q Trunk to enable the trunking and later bundle these two ports into an EtherChannel group.

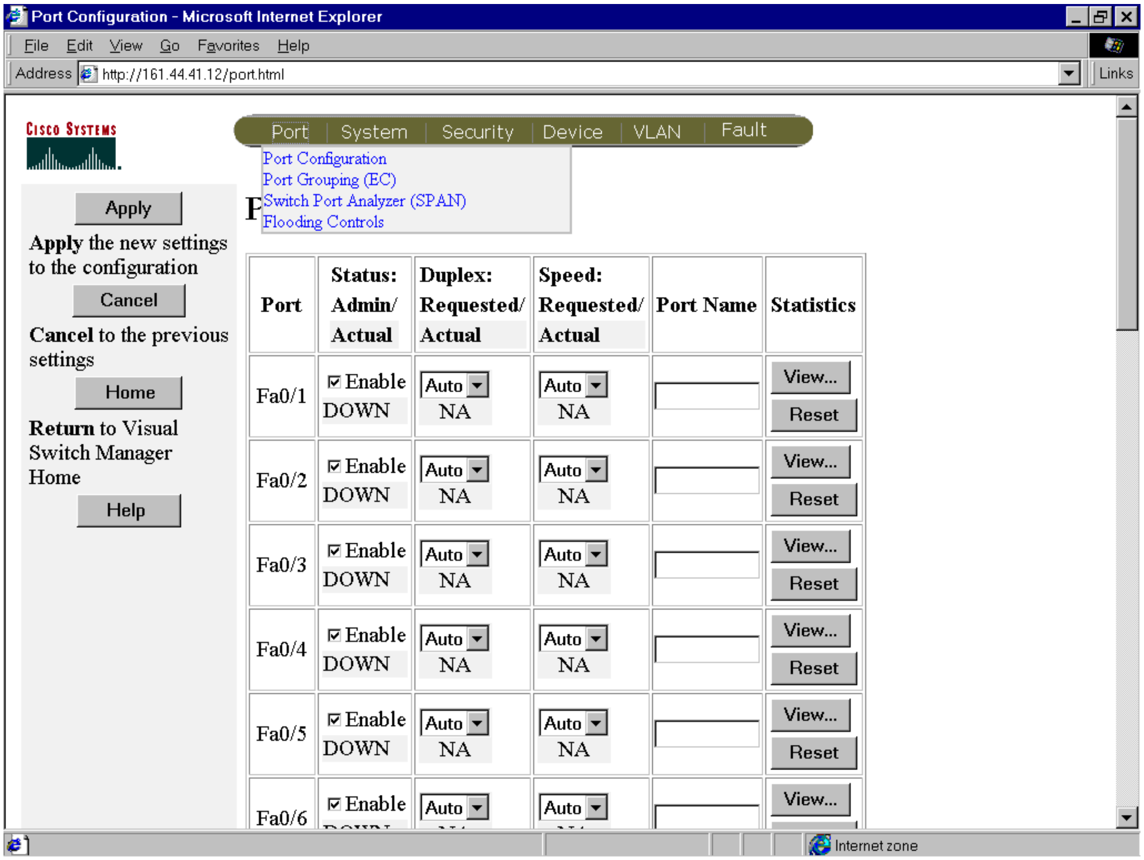

Figure 21. Port Configuration

For port configuration, click **Port** -> **Port Configuration** (Figure 21). By default all ports are enabled and speed and duplex are set to AUTO. We will leave them as the default, and later see that Port 7 and 8 are using auto-speed and duplex mode.

Note

It is safer to always configure the trunk ports to fixed values, in this case to 100 Mbps and duplex mode. On some rare occasions the automatic speed/mode negotiation may fail to reach the best speed/mode due to limited resources of the boxes at the time of the negotiation.

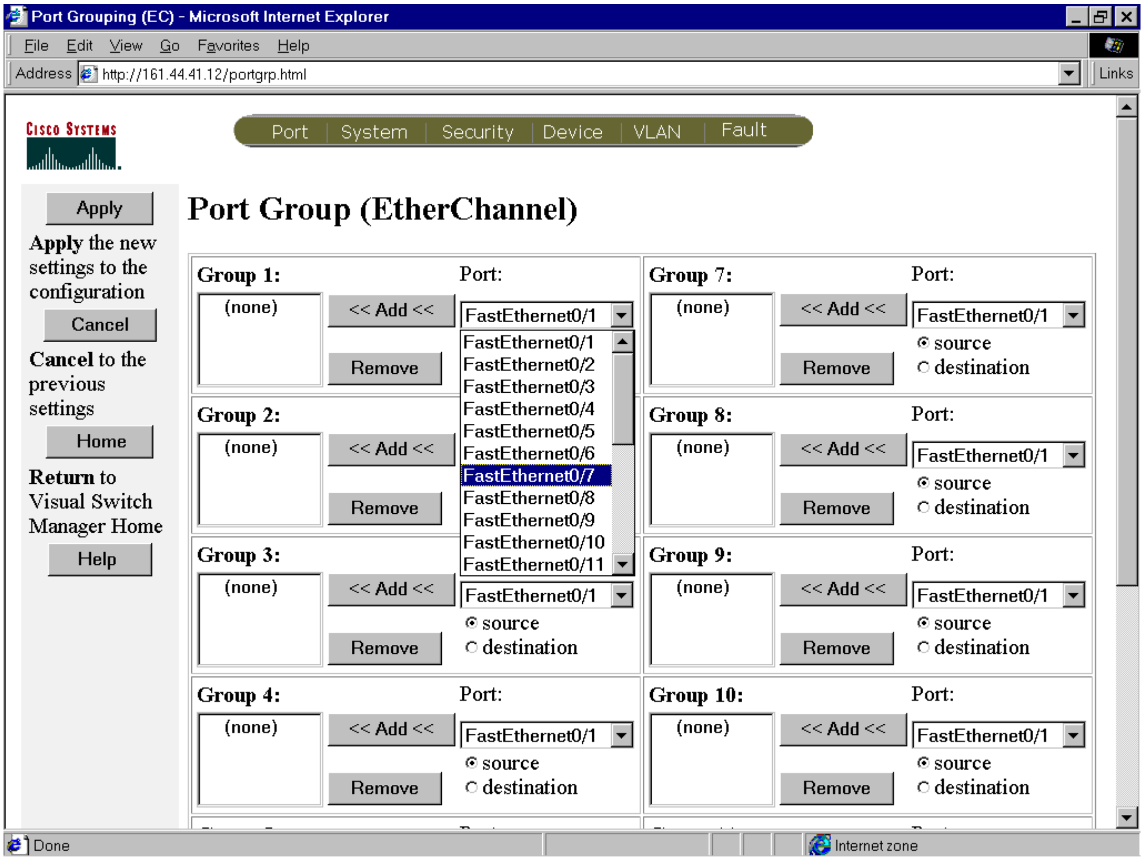

Figure 22. Port Grouping

To configure the EtherChannel and Port Group, from the CVSM Main Menu (Figure 21) we choose **Port Grouping (EC)**. This brings us to the Port Group (EtherChannel) window shown in Figure 22. We add FastEthernet0/7 and FastEthernet0/8 ports to Group1 by selecting the port from the pull-down menu, which is shown in Figure 22.

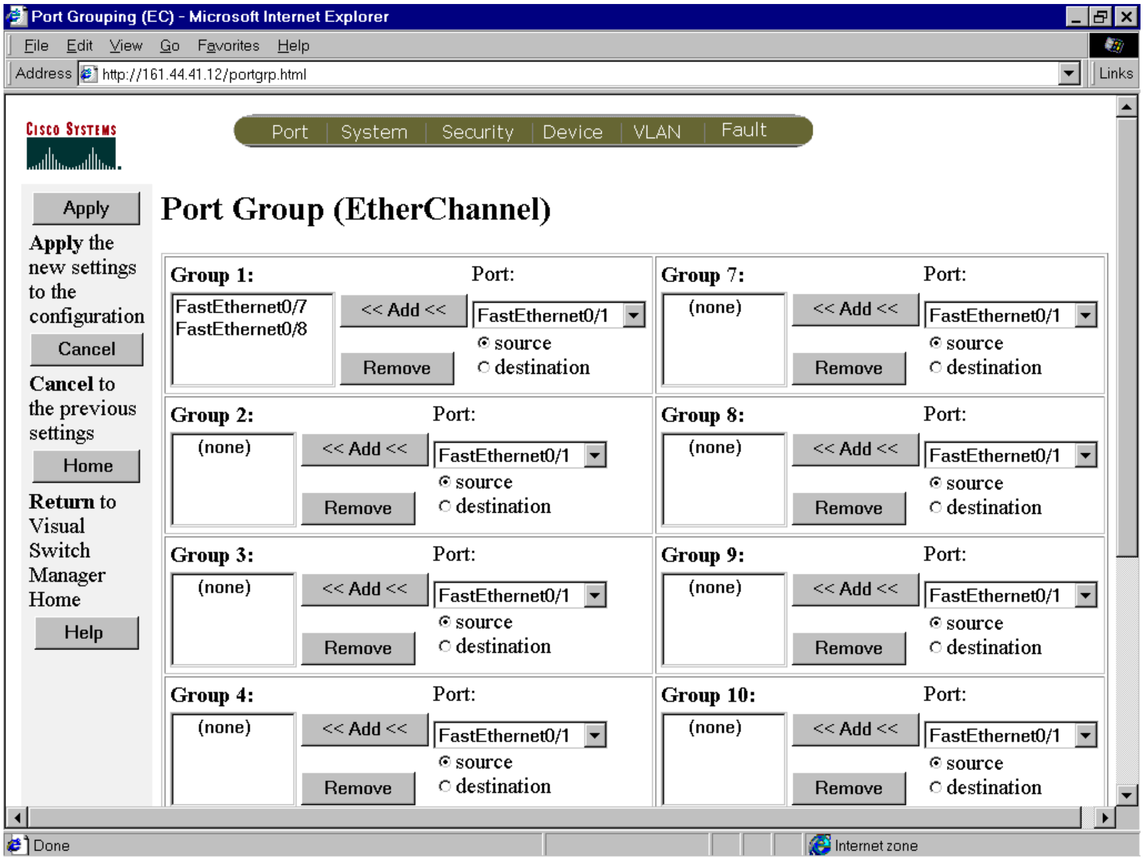

Figure 23. Port Grouping (EC) EtherChannel

Figure 23 shows both FastEthernet0/7 and FastEthernet0/8 ports added to Group 1. Now we have an EtherChannel (Trunk).

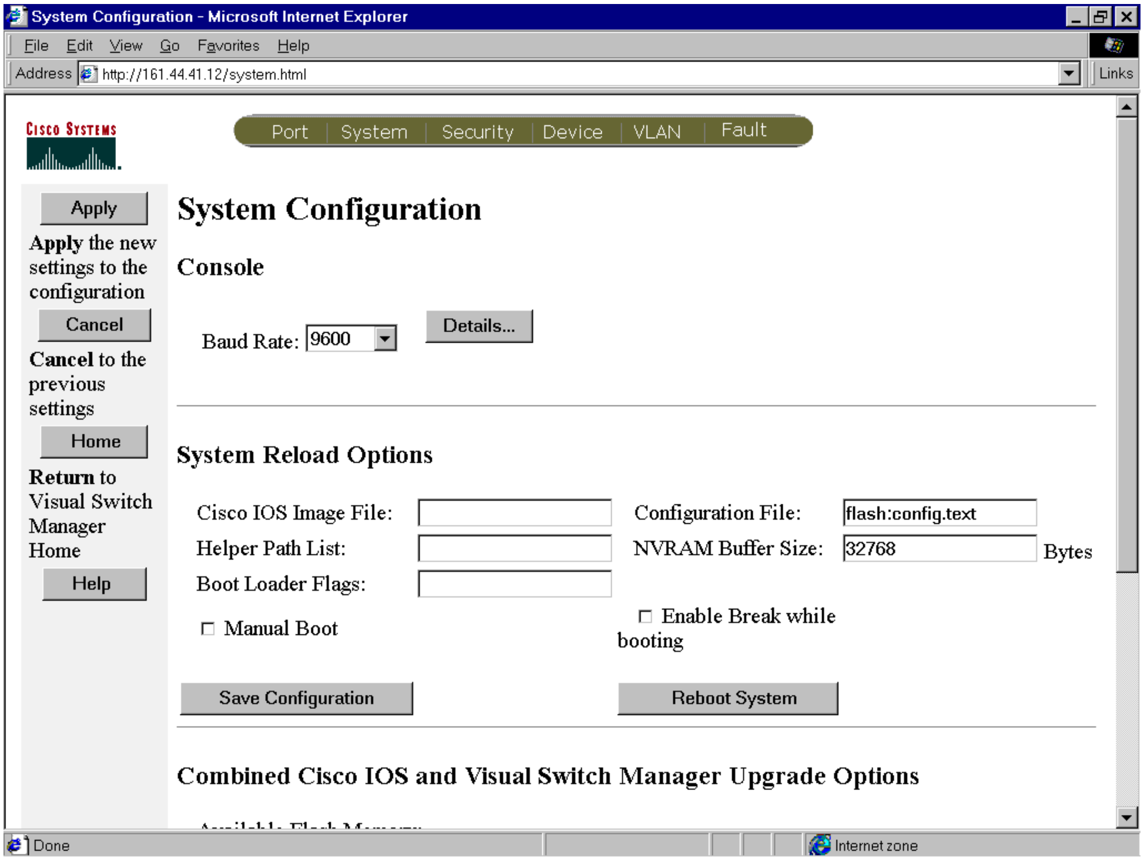

Figure 24. Save configuration and reboot

From the System Configuration Menu we choose **Save Configuration**, shown in Figure 24. This will force the switch to save the configuration to NVRAM for a future reboot of the system. A Reboot System is not required now since the changes have already been made to the running configuration.

Now we connect port 1.9 from the 8275-322 Switch, to port 0/7 on the Cisco 2924-XL, and port 1.10 to port 0/8. We connect one workstation to each switch, and start pinging between the workstations. We have connection and it seems to lose only one ping or none, when we disconnect one of the two connections that forms the trunk. Everything works fine, and the configuration was easy. From Figure 25 on page 46, we can see that the ports have discovered speed and duplex mode from auto negotiating.

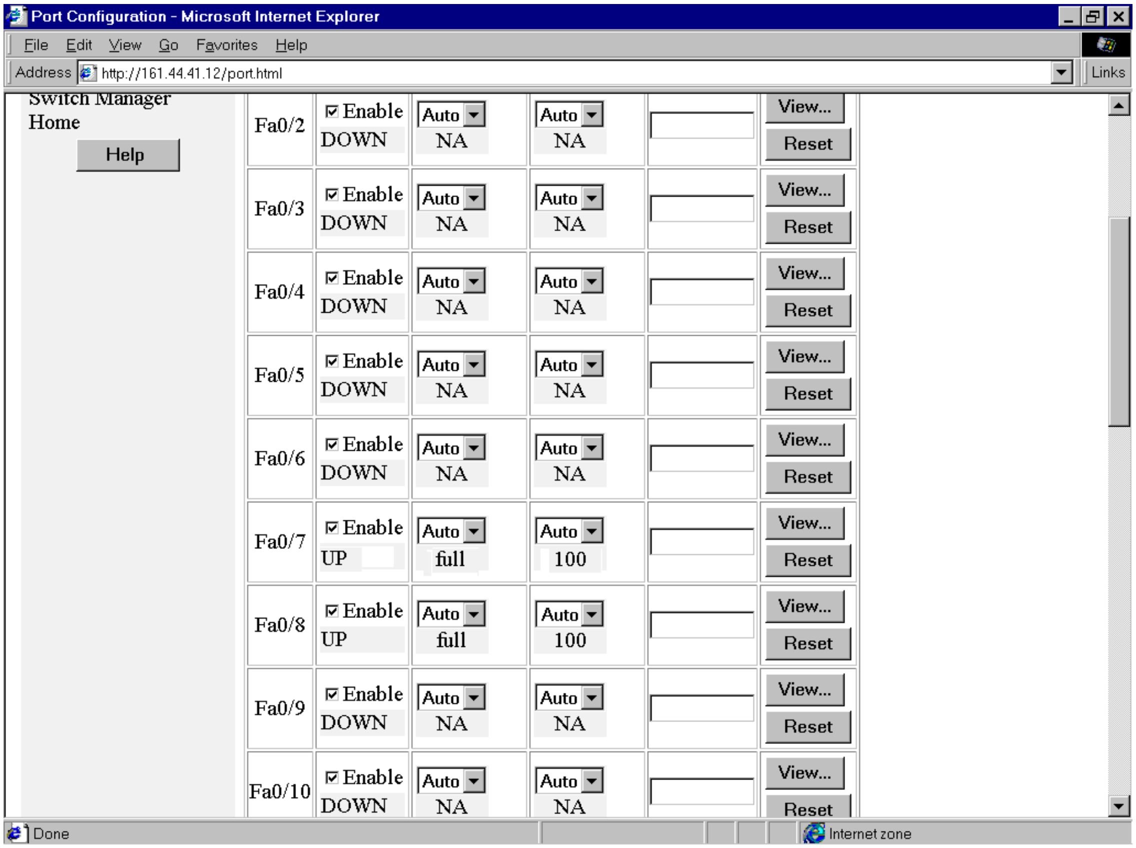

Figure 25. Port Fa0/7 and Fa0/8

The EtherChannel port Fa0/7 and Fa0/8 are operating 100 Mbps full duplex.

3.3.1.4 Lab 1 conclusions and verification of the configuration

We performed a simple test at the end of this lab. We connected one workstation to each switch and started a ping from both to the other. When we broke part of the trunk, the trunk connection itself did not break. We preferred configuring both switches via the Web interface compared to the command-line interface.

3.3.2 Lab 2: VLAN and trunking on IBM 8275 and Cisco 2924

This test will be more complex than “Lab 1: Trunking IBM 8275-322 and Cisco 2924-XL” on page 27, in the sense that we now will have three VLANs on both switches, and will interconnect them over the same trunk.

We use the same Cisco 2924-XL switch, but change to an IBM 8275-225, so both switches support IEEE 802.1Q trunking.

In this test we will focus on the security between VLANs, tagging frames for trunking VLAN, and the VLAN trunk itself.

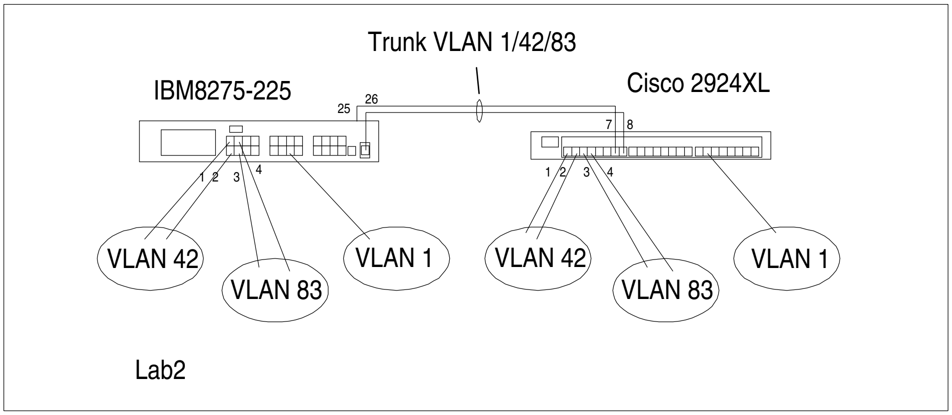

Figure 26. Lab 2, physical connections and VLANs

Figure 26 shows the physical connections and the VLAN ports for lab 2. We use VLANs 42 and 83 over the trunk. VLAN 1 is the default.

3.3.2.1 Configuring the IBM 8275-225 Switch

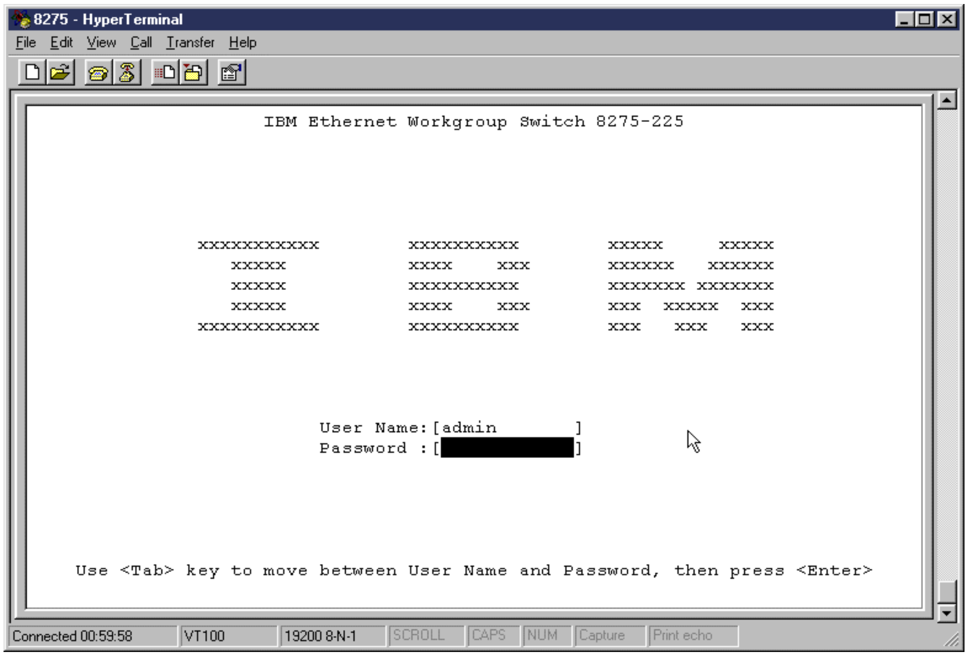

Figure 27. Accessing IBM 8275-225 Switch

We start by connecting a workstation running HyperTerminal to the service port on the 8275-225 switch. As the connection is established, we are prompted for a user name and a password as shown in Figure 27. The default user name is `admin` and no password.

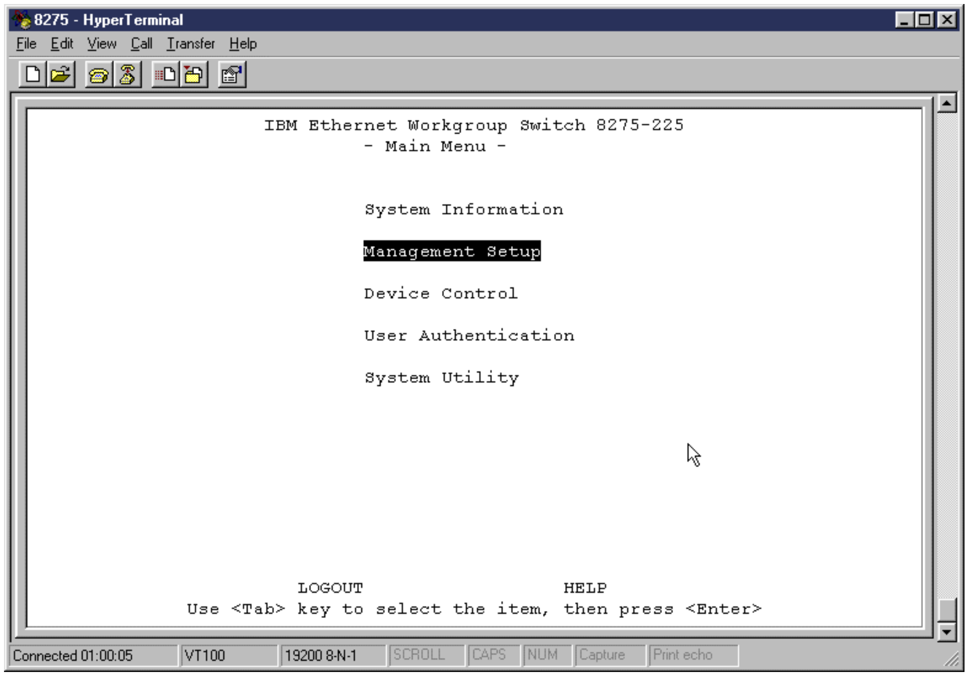

Figure 28. 8275-225 Main Menu

From the menu choose **Management Setup** and then **Network Configuration** to get to the Network Configuration Menu, shown in Figure 29 on page 50.

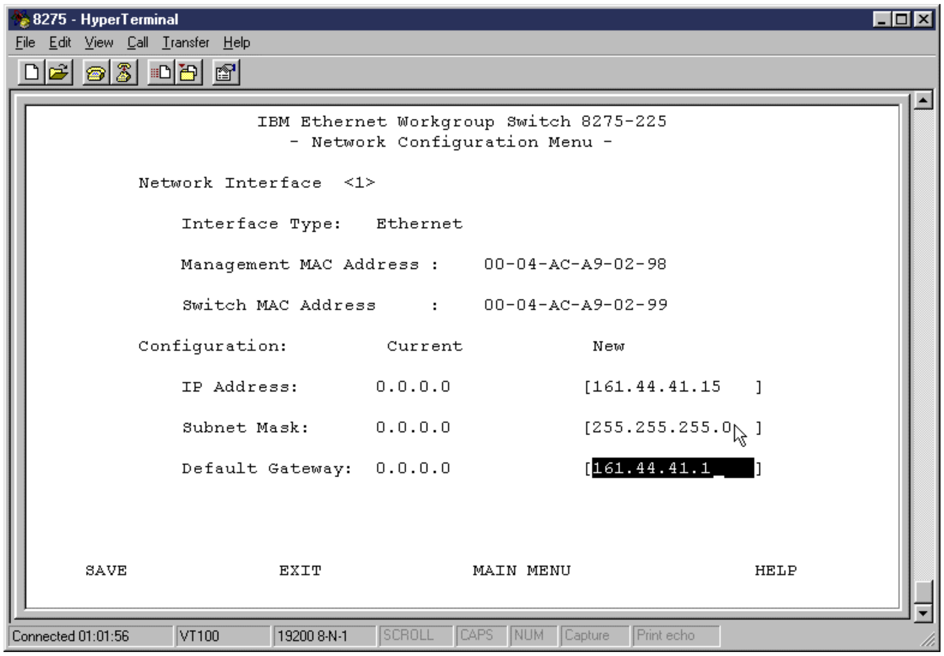

Figure 29. Network Configuration Menu

Network Interface 1 is the default. That means VLAN1 is management VLAN.

We set IP address to 161.44.41.15, Subnet Mask to 255.255.255.0, and Default Gateway to 161.44.41.1. Save the changes and exit back to the Main Menu from where we enter the System Utility Menu to make a System Restart as shown in Figure 30 on page 51.

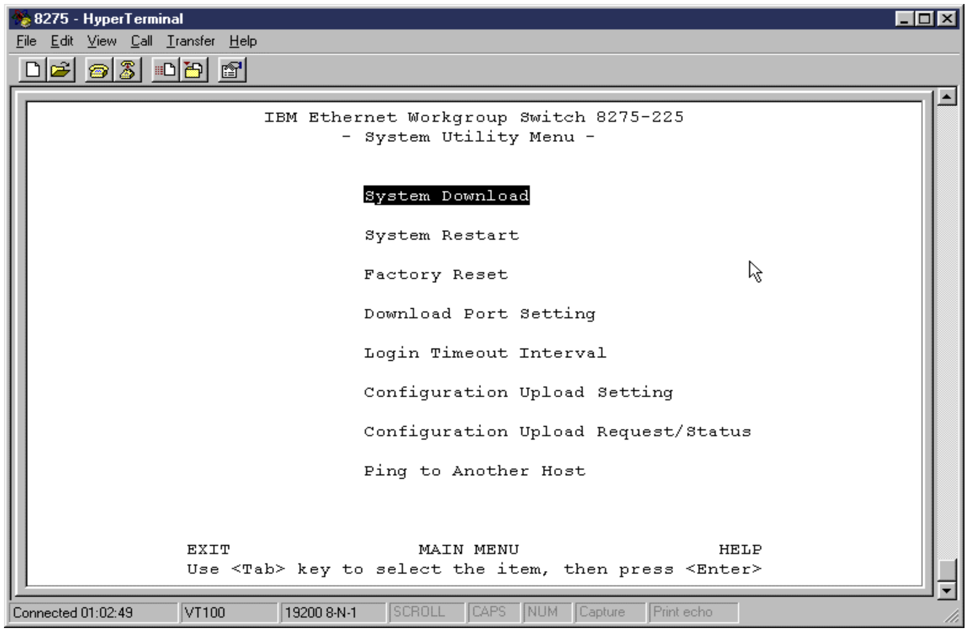

Figure 30. System Restart

The switch must be restarted for the changes to take effect. After the switch is back online, we access it via the Web browser by typing `http://161.44.41.15` on the address line of our Web browser, as shown in Figure 31 on page 52.

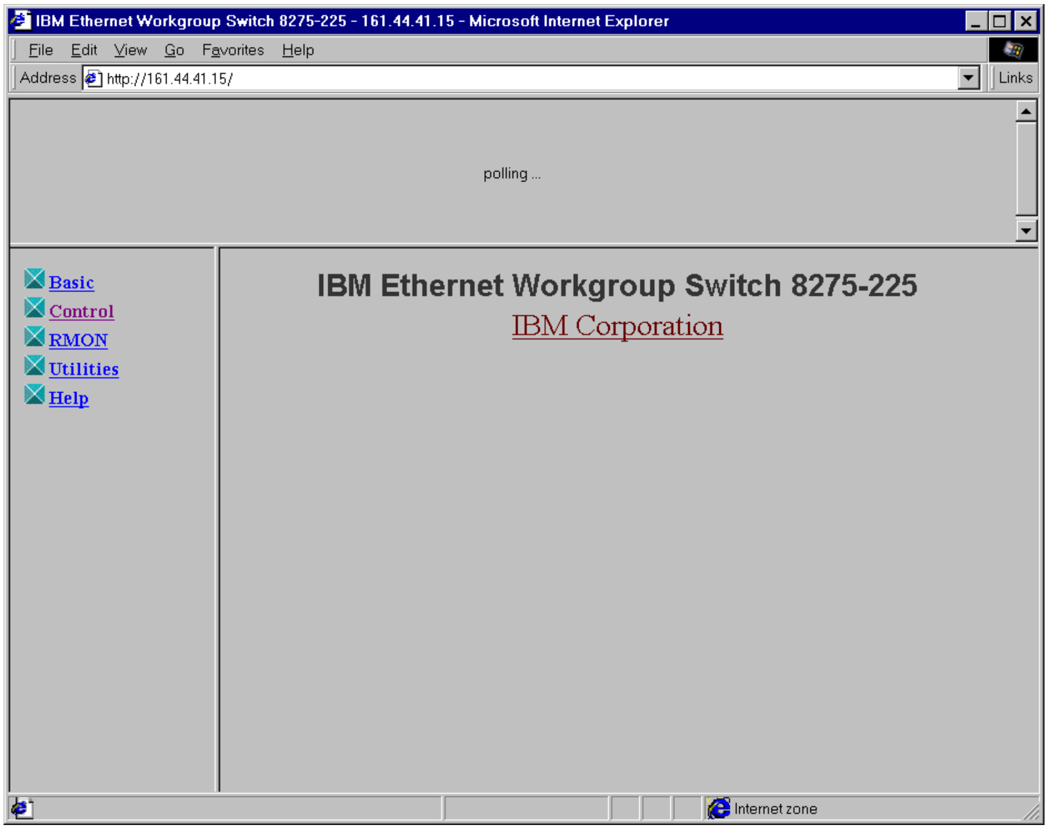

Figure 31. IBM 8275-225 Web pages

The Web interface of the IBM 8275-225 is divided into three parts. The top part is a status window, to the left is the navigating window, and the main part is the worksheet as shown in Figure 31.

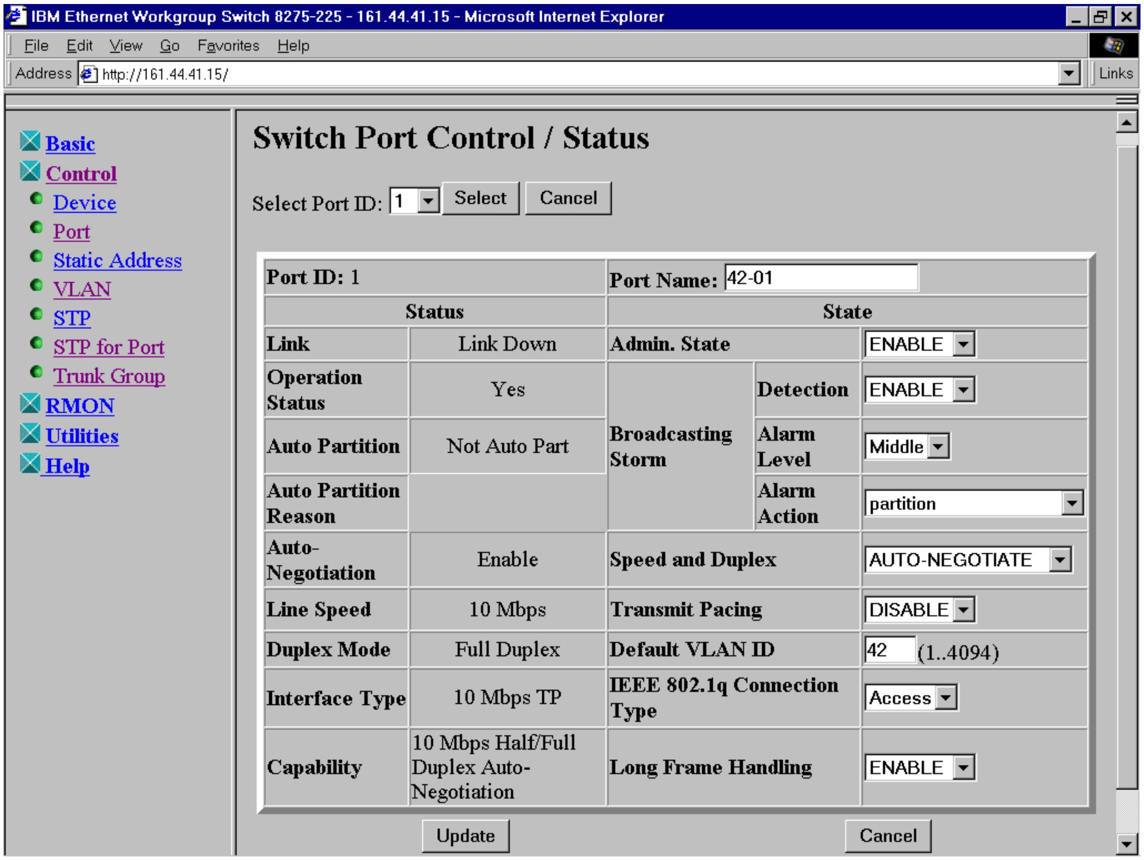

Figure 32. Switch Port Control / Status: Port 1

From the navigation window, we choose **Control** and **Port**. That brings us to the Switch Port Control window shown in Figure 32. We select **Port ID 1**. Then we set the Port Name to 42-01, 42 as the VLAN ID, and 01 as port number 1. This is the first of two ports on VLAN 42.

The speed and duplex are set to AUTO-NEGOTIATE by the default and were left unchanged in our test environment. See “Auto-speed negotiation” on page 8.

Transmit pacing is set to DISABLE. When the pacing is on, the switch will sense high network traffic and insert extra delays between frame transmissions. There is no interoperability issues about transmit pacing, since it only controls sending.

IEEE 802.1Q Connection type can be set either to Access or Hybrid.

An *access* port is intended to connect to a network with untagged devices only. When a frame arrives at an access port, it becomes a member of the VLAN that is set by the default VLAN ID (or PVID). As the frame enters the switch, it is tagged with a VLAN tag with a value equal to the PVID of the port. This frame is then sent to other ports in the switch that belong to this VLAN.

Hybrid ports are used for trunks. A hybrid port can receive and send both tagged and untagged frames when at least two VLANs are configured on the port. If an untagged frame is received at a hybrid port, it follows the same rules as an untagged frame received at an access port. The untagged frame will have a tag inserted with a value equal to the PVID of the port and the frame will be switched to the set of ports that belong to this VLAN. For any VLAN all frames must be either tagged or untagged, not mixed.

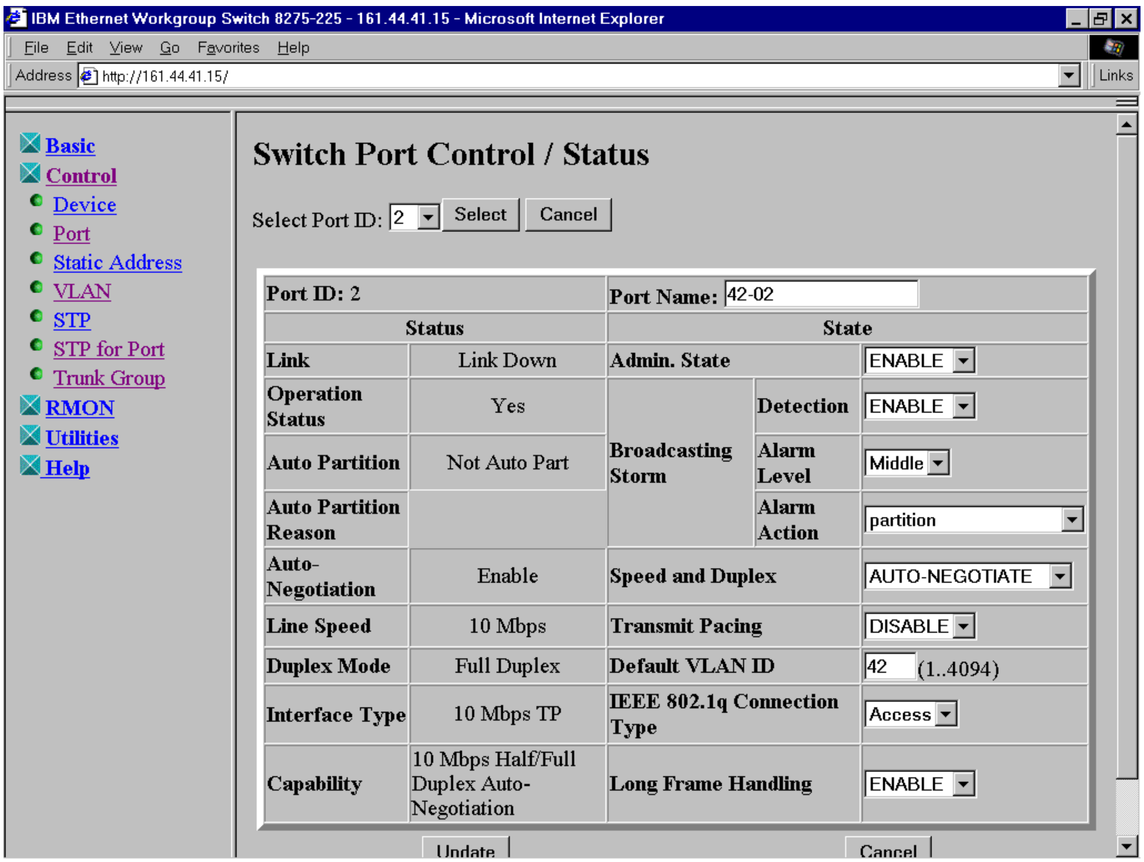

Figure 33. Switch Port Control / Status: Port 2

Now we set up the second port, Figure 33. We set the port ID to 2 and its name to 42-02. The default VLAN ID is 42 and the 802.1Q type is Access.

Long Frame Handling is set to ENABLE, which means that frames according to IEEE 802.3ac are supported. This support is required because of the VLAN tag, which will be added to the frames.

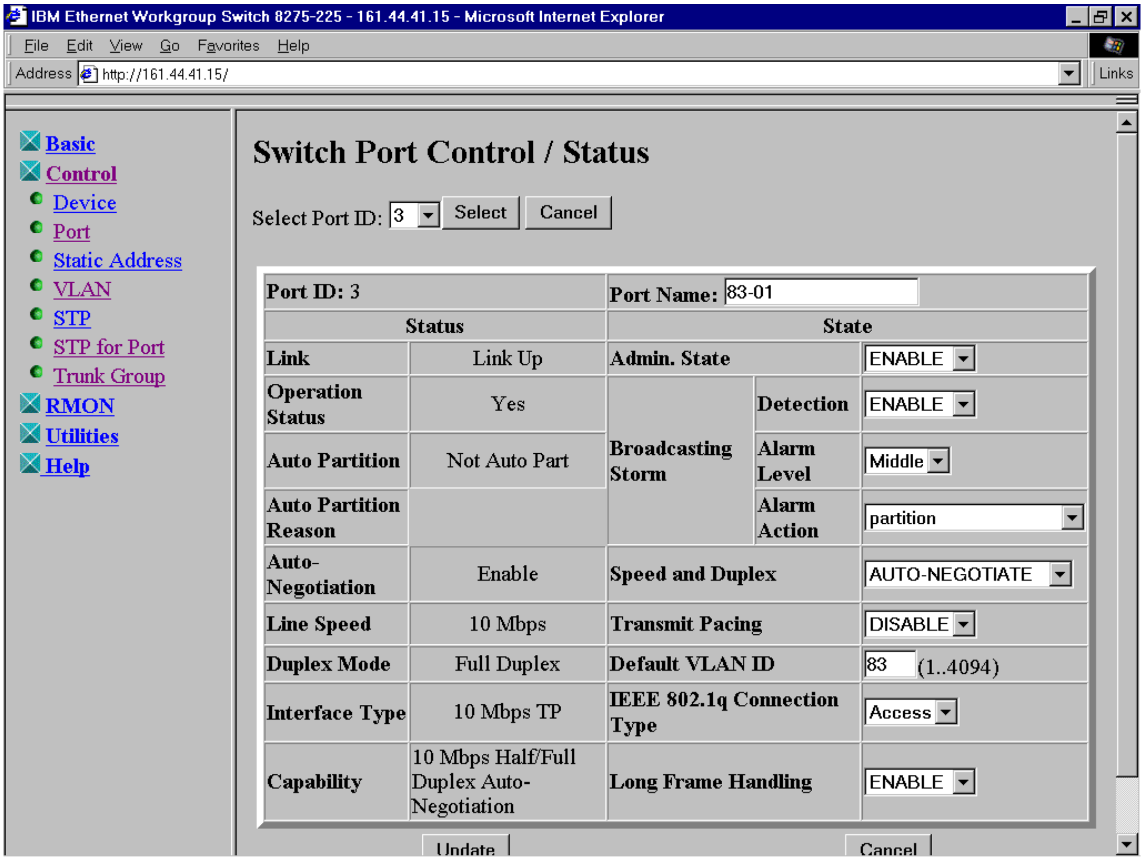

Figure 34. Switch Port Control / Status: Port 3

The third port will be port ID 3. The Port Name is set to 83-01 and the default VLAN ID is 83.

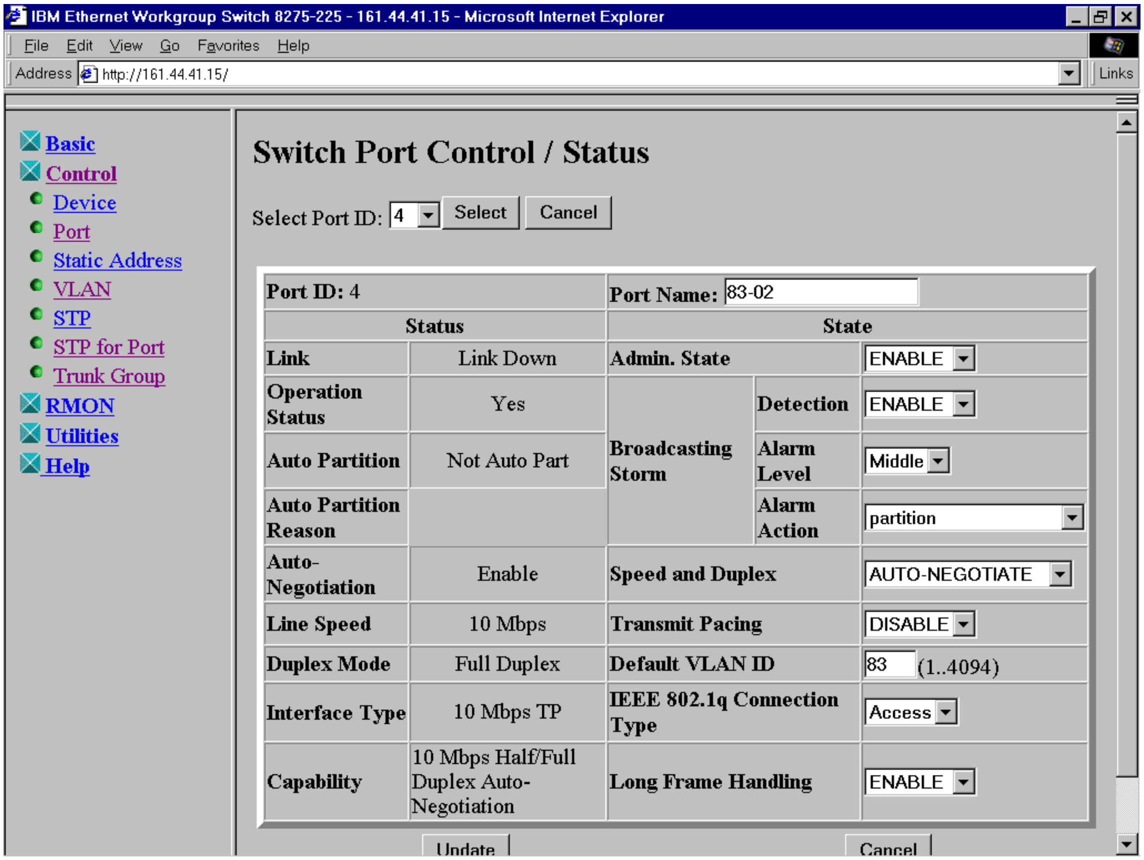

Figure 35. Switch Port Control / Status: Port 4

The fourth port has the Port ID 4 and Port Name 83-02 since it will become a member of the 83 VLAN. The IEEE 802.1Q Connection Type is Access as for the other ports.

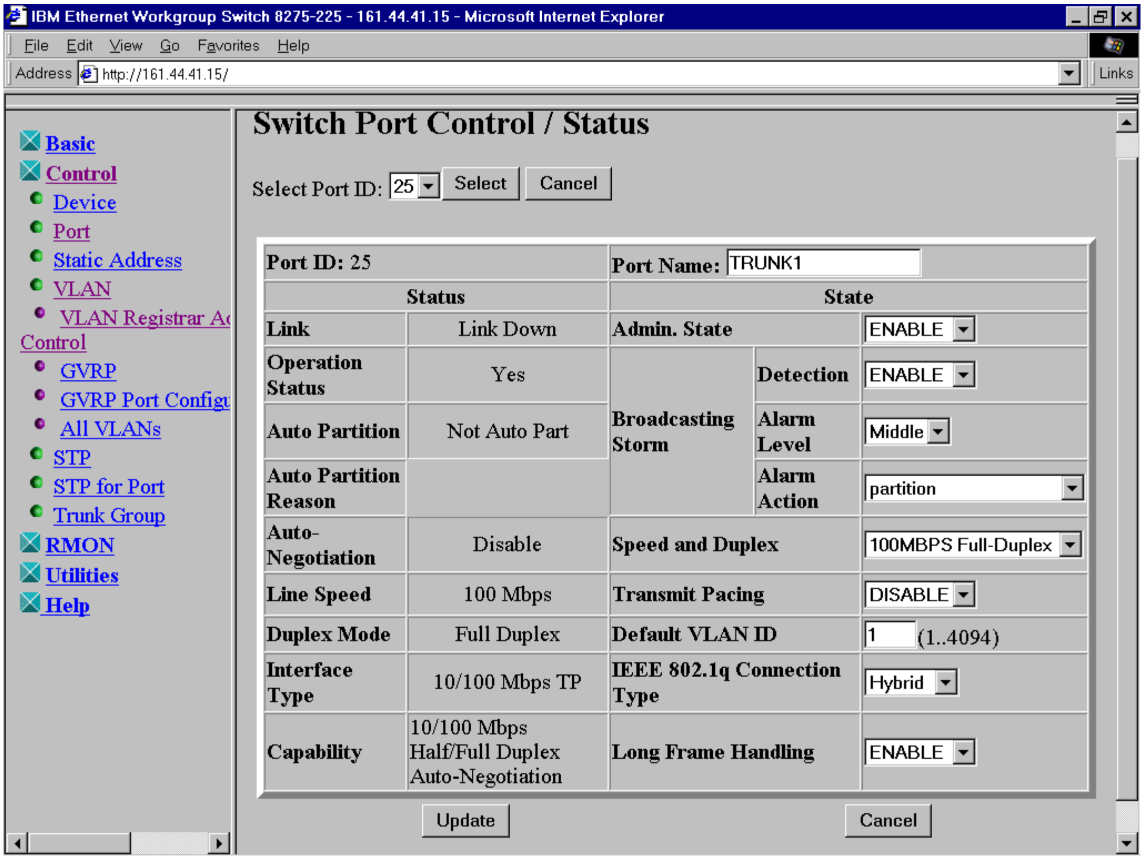

Figure 36. Switch Port Control / Status: Port 25, TRUNK1

This port is different, as it will be part of the TRUNK1 between the two switches. The Port ID is 25 and the name is TRUNK1. IEEE 802.1Q Connection Type is changed to Hybrid. The Speed and Duplex field is now fixed to 100MBPS Full-Duplex.

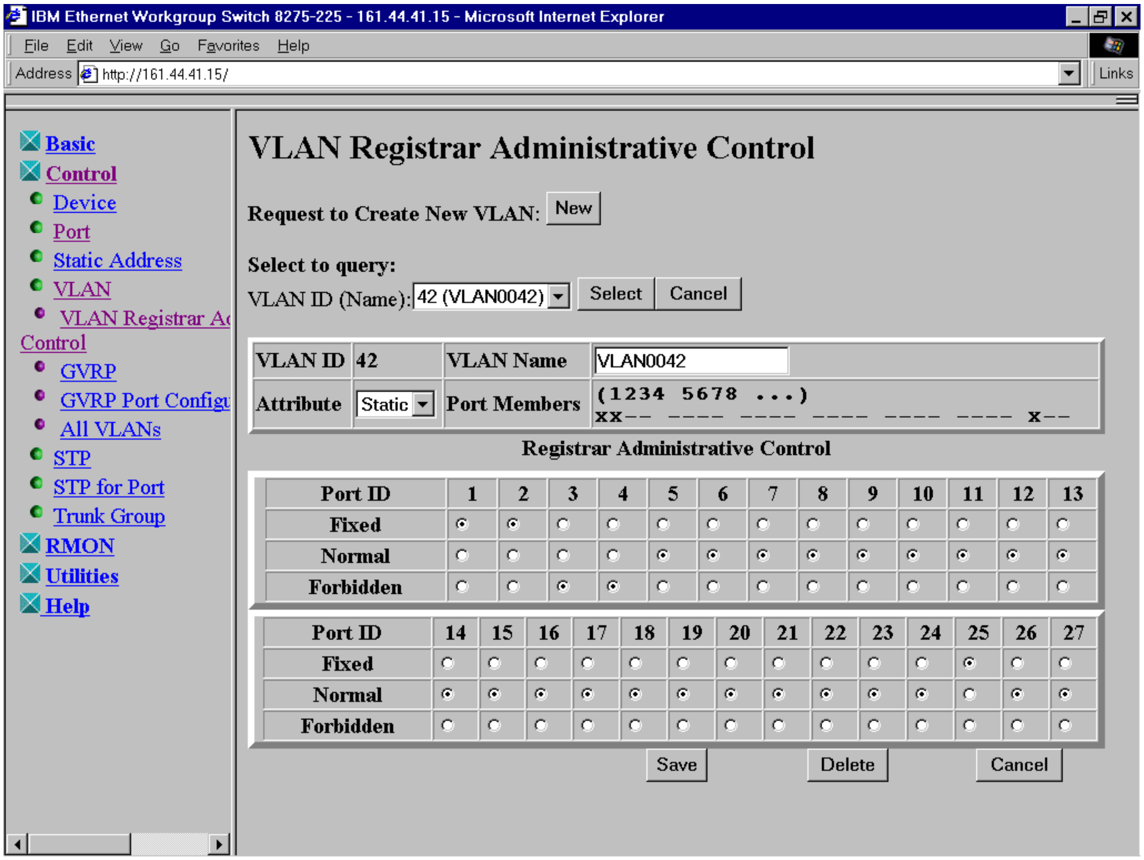

Figure 37. VLAN Registrar Administrative Control: VLAN0042

Now we move to the VLAN Registrar Administrative Control window. We select VLAN ID 42 (VLAN0042). As can be seen from the Port Members field, ports 1, 2 and 25 take part in VLAN0042.

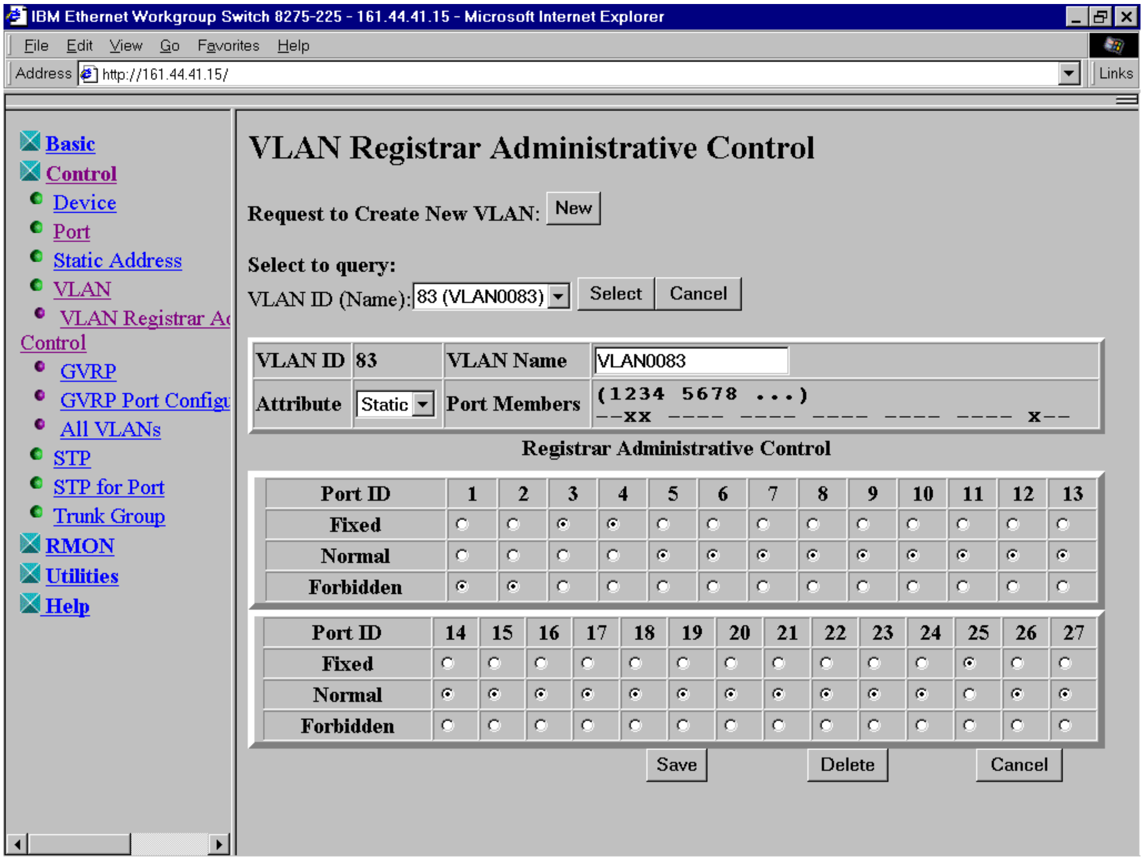

Figure 38. VLAN Registrar Administrative Control: VLAN0083

As for VLAN0042 in Figure 37 on page 58, we can see the port members of VLAN0083. They are ports 3, 4 and 25.

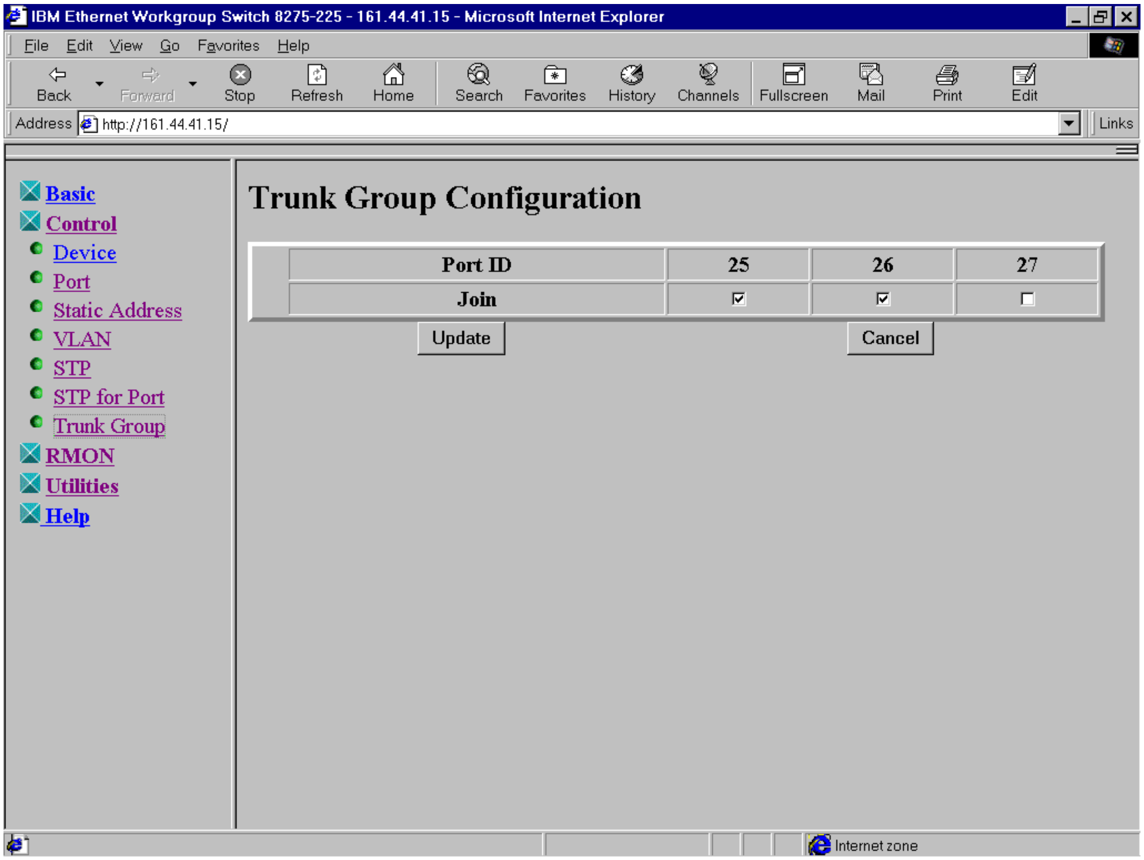

Figure 39. Trunk Group Configuration

Now we join port 26 to TRUNK1 (port 25 already joined) to create a Trunk Group. The configuration of the switch 8275-225 is completed for this test.

3.3.2.2 Configure the Cisco C2924-XL Switch.

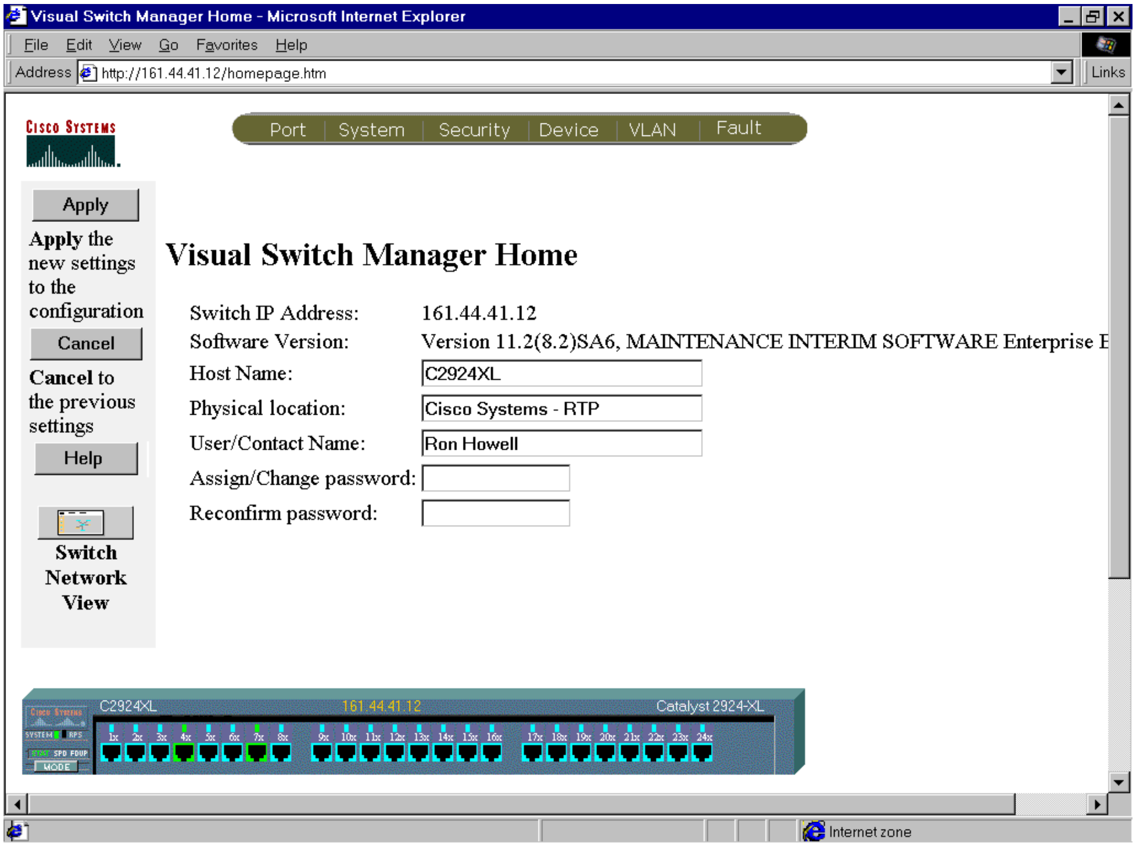

Figure 40. CVSH Home Page

As this switch is the same as the one used in the first Ethernet test in “Lab 1: Trunking IBM 8275-322 and Cisco 2924-XL” on page 27, the initial IP configuration procedure is the same. After it we are able to access the switch from our Web browser.

We leave the ports at their defaults, auto-sense speed and duplex and go straight to the VLAN configuration by choosing **VLAN** from the menu shown in Figure 40.

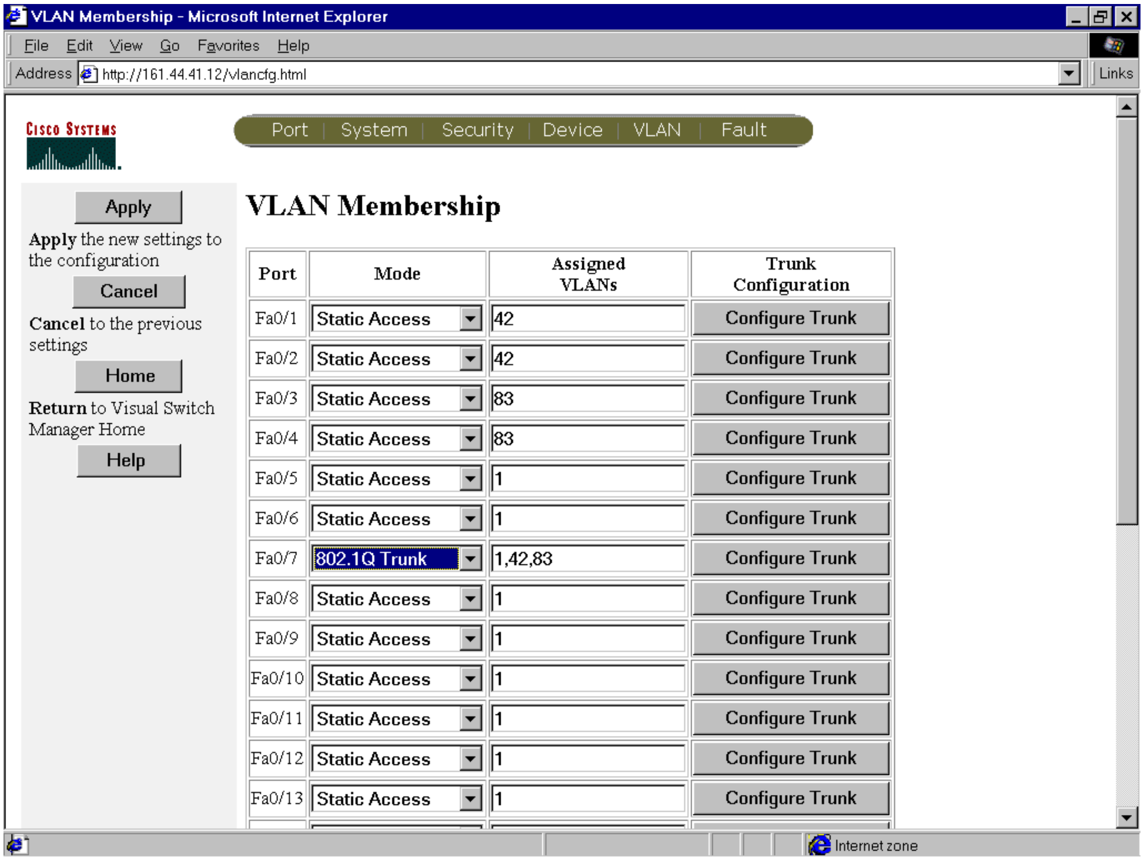

Figure 41. VLAN Configuration

First we need to assign ports Fa0/1, Fa0/2, Fa0/3 and Fa0/4 to new VLANs (default is VLAN 1). Port Fa0/1 and Fa0/2 are assigned to VLAN ID 42, and ports Fa0/3 and Fa0/4 to VLAN ID 83.These IDs will be used when frames are tagged (labeled), and have to be equal to the VLANs we have already configured at the IBM Switch. All VLAN ports are left at Static Access Mode to know what VLAN the port is belonging to. Choosing dynamic VLAN means that the switch would map the port to a specific VLAN based on the workstation's MAC address with the help of an external server called VLAN Manager Policy Server. We do not use that feature.

Building the VLAN Trunk begins with setting the Mode, **802.1Q Trunk**, in the VLAN Membership menu, in our case for port Fa0/7. We click the **Configure Trunk** button for Port Fa0/7 in the VLAN Membership menu, to access the **Port FA0/7 Trunk Configuration** window shown in Figure 42 on page 63.

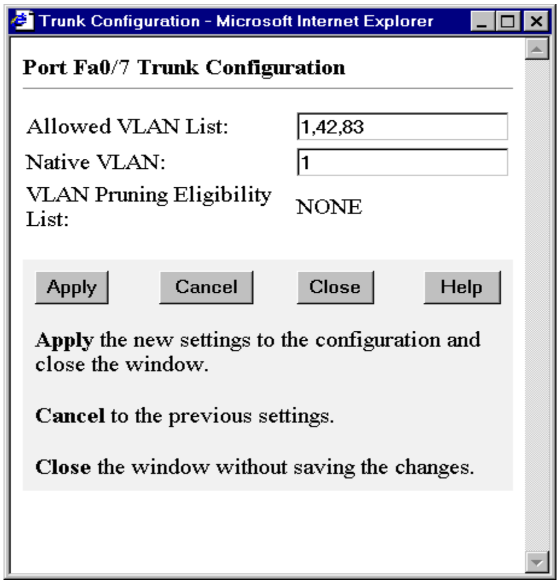

Figure 42. Trunk Configuration

We add 42 and 83 into the allowed VLAN List, and click the **Apply** button to save the settings and close the window. We repeat the same for Port Fa0/8, to create the other half of our trunk.

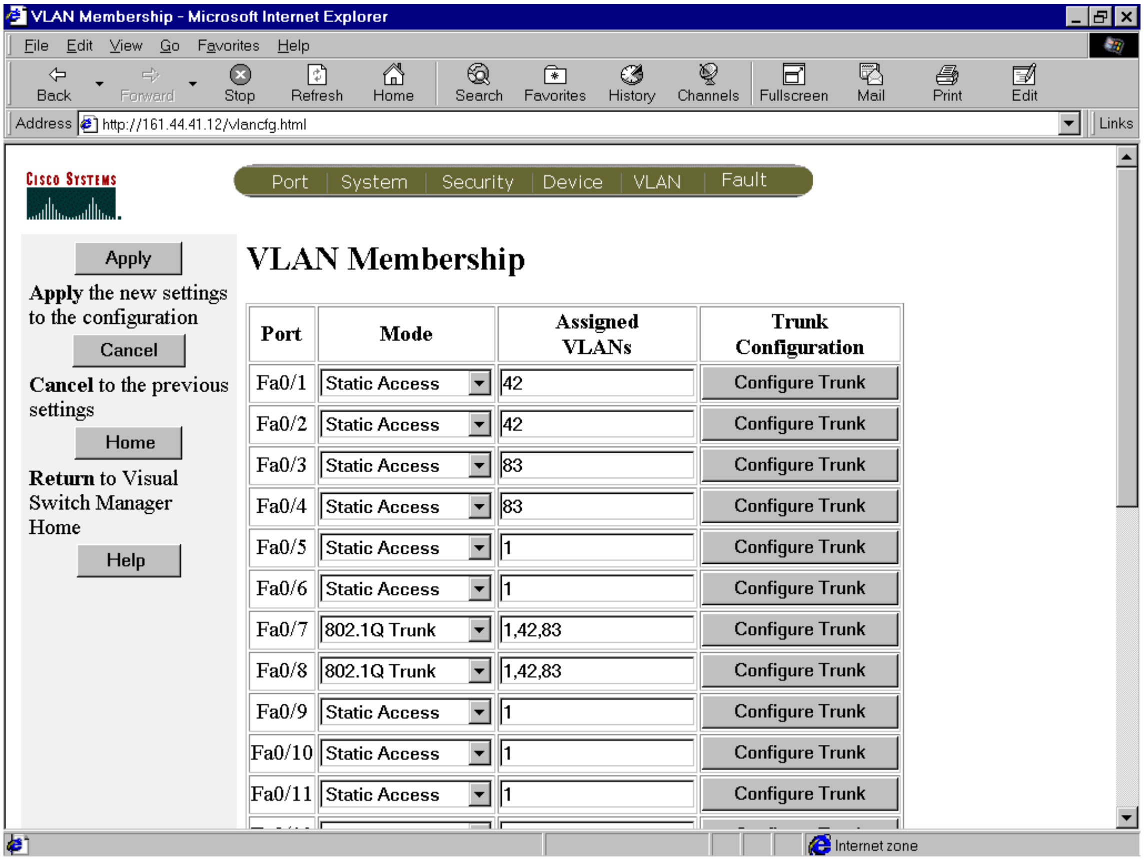

Figure 43. VLAN Membership

Now that we have assigned the ports we want to use, we have to move back to the Port Group (EtherChannel) menu (Figure 23 on page 44), and add port Fa0/7 and Fa0/8 to Group 1, as we did in the earlier “Lab 2: VLAN and trunking on IBM 8275 and Cisco 2924” on page 46. Now we have configured the EtherChannel, and end the task by clicking **Apply** to apply the changes to the configuration.

3.3.2.3 Lab 2 conclusions and verification of the configuration

To verify our configuration we connected workstations to ports Fa0/1 to Fa0/4 on the Cisco switch, and ports 1 to 4 on the IBM switch. We used a “ping test” to verify connectivity between the ports at the two switches, as well as connectivity between the two switches connected together with the EtherChannel. To verify the VLAN connectivity over the trunk as well as the trunk’s capability to partly recover loss of connectivity,we disconnected one

half of the EtherChannel Trunk, reconnected it, and did the same to the other half. We saw no breaks between VLANs, and no errors appeared. The tag function on both switches worked as specified in IEEE 802.1Q specification.

Both the switches were easy to configure. There should be no problem in getting a configuration like this up and running, as long as the user is aware of the individual switches' features and capabilities. There might be functional differences in different operational code, so read the Release Notes carefully.

Chapter 4. ATM LAN backbone interoperability and migration

In this chapter we consider a typical scenario of an installation based on an IBM 8265 ATM backbone. In all probability, this backbone operates well, there are no bottlenecks, and it scales well by adding more nodes and/or edge devices when more capacity is required.

The ATM core of such a network is rarely saturated, and we may expect that the life of ATM switches will extend several years from today. However, the market direction is clearly to use Gigabit Ethernet at the edges of the network to attach servers and workstations.

The IBM-Cisco alliance is an opportunity to position the ATM backbone for a future migration. We discuss a migration to a Gigabit Ethernet backbone, which we consider most likely today, but certain requirements may mandate that an ATM core is maintained even in the future.

In the last part of this chapter, we describe in some detail how we added a Cisco Catalyst 5500 LANE Module to an Ethernet ELAN as an MPOA client to our laboratory network and established short-cut routing between the Catalyst 5500 and an IBM 8270 token-ring switch with an MSS client uplink.

4.1 ATM LAN backbone migration scenario

This migration scenario consists of three steps:

1. First we take a look at what may be characterized as a typical ATM LAN backbone.
2. Then we develop an interoperability solution that provides greater flexibility in connecting servers and workstations. We base the solution on the overlay principle. This way we enable an orderly migration to an Ethernet backbone.
3. Finally, we discuss when or whether it is desirable to eliminate the ATM backbone.

4.1.1 A typical ATM LAN backbone

The network depicted in Figure 44 on page 68 may solve many requirements for an organization. Some of them are listed below. Undoubtedly this versatility has been the reason for many customers to choose such a solution. The network has been simplified to better illustrate the basic principles. A real-life network will often consist of considerably more equipment including several ATM backbone nodes, and servers are often distributed to the

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physical Ethernet and token-ring LANs, and not only attached to the ATM backbone. This does not affect the principles of our scenario.

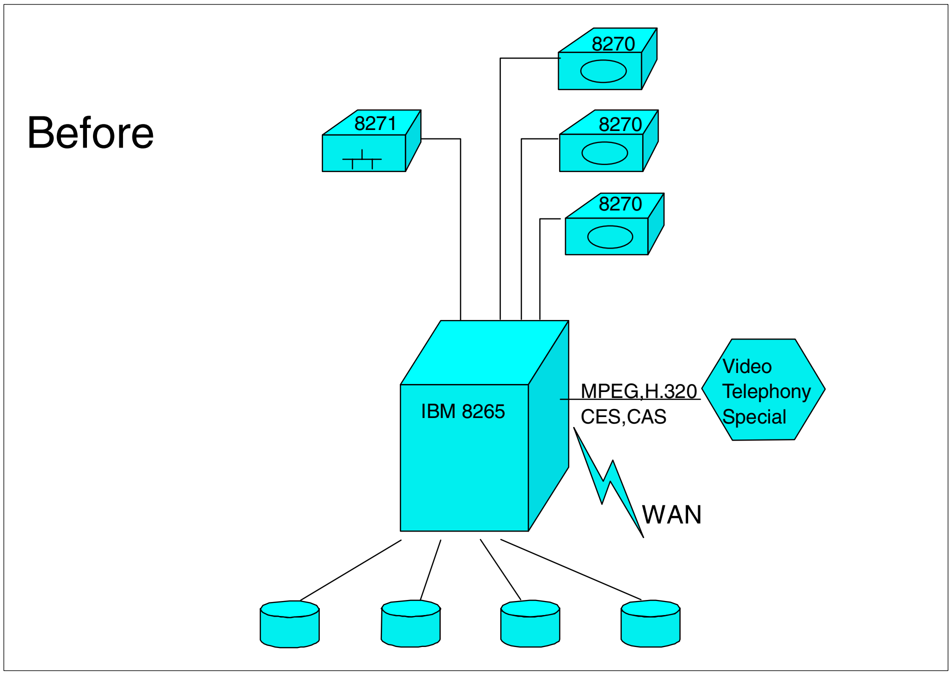

Figure 44. ATM LAN backbone before migration

The solutions this network provides for its users include:

- High-capacity backbone for token-ring LAN
- High-speed server connections
- Managing broadcasts
- Integration of Ethernet and token-ring
- Interfacing multimedia equipment
- Sharing bandwidth between data and telephony transports
- Bridging special-purpose ATM equipment to legacy LAN

It is likely that this network started as pure token-ring. Then the traffic on the backbone ring grew and the servers needed more bandwidth. Technical applications on UNIX workstations demanded Ethernet. The server connections support both emulated Ethernet and emulated token-ring, but

there is little traffic between the Ethernet and token-ring ELANs. This traffic is easily bridged or routed by the MSS.

Token-ring was chosen and may continue to be the LAN technology of choice for workstation attachment. However, the market has chosen Ethernet, and technological developments have compensated for most of the earlier shortcomings of Ethernet. Economy and wider choices with Ethernet motivate this organization to start a migration to Ethernet. So the first step in a migration should be to enable an overlay Gigabit Ethernet backbone.

4.1.2 The migration phase

As all who have gone through a major technology migration have experienced, it requires meticulous planning. However, clever use of available technologies can provide a great deal of flexibility to the migration process to ease some of the restraints that would otherwise have to be put on the network and its users.

Figure 45 on page 70 shows a workable solution for migrating via an overlay Ethernet backbone.

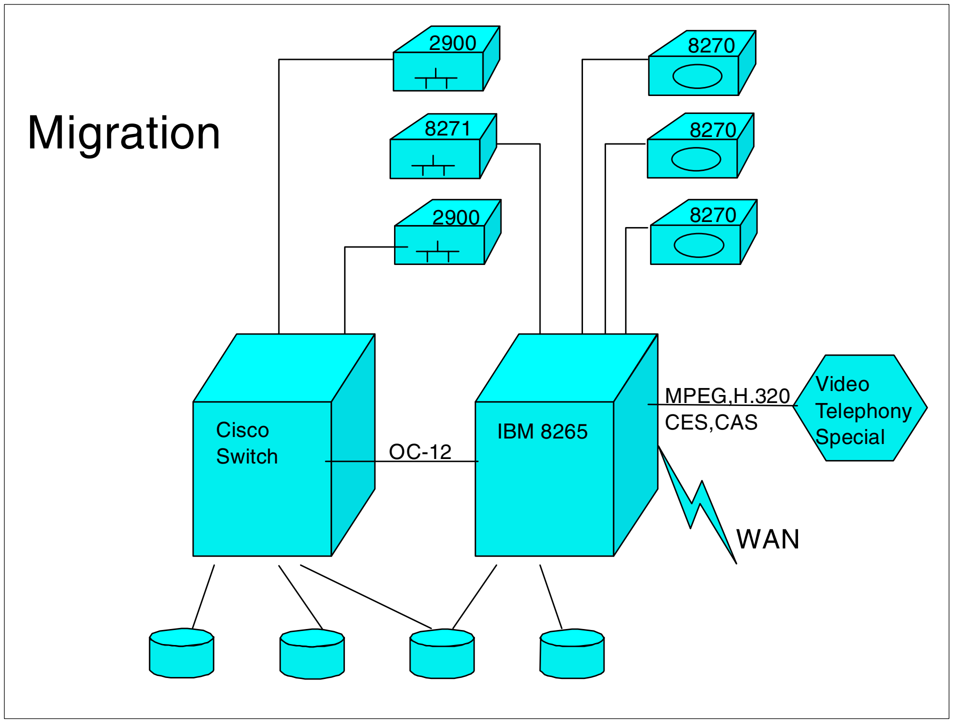

Figure 45. Overlay Ethernet backbone for migration

There are several challenges in this migration phase. As we intuitively feel from looking at Figure 45, most of the challenges stem from the server connections.

To make the entire process manageable, It would probably be a good idea to start by moving all or most of the servers to the Ethernet backbone. We need to do so because there is often no or only a little proximity between user workstations and servers. In other words, the group of users that use a particular set of servers have usually been scattered over all the workstation segments as time has passed.

Moving the servers from the ATM backbone to the Ethernet backbone also presents an occasion for some degree of server consolidation, if this should be desirable at the time.

If we stage the migration so that we first migrate all the servers, and subsequently the workstations are migrated to Ethernet, for instance as they are upgraded to newer versions that have on-board Ethernet adapters, clearly

we face the challenge that all the servers reside on Ethernet segments or VLANs, and all the workstations are on a token-ring.

As the migration of the workstations may well extend over one or two years, our migration solution must provide ample bandwidth and capacity for bridging or routing between physical as well as emulated Ethernet and token-ring LANs.

The developers at Cisco Systems had already anticipated this requirement. They chose to make the first - and so far only - ATM LAN adapter for Catalyst 6500 an OC-12 adapter with a speed of 622 Mbps.

The Catalyst OC-12 adapter has an on-board LAN emulation client as well as an MPOA client. This suits our purposes very well. In addition, it provides for a LAN Emulation Server (LES) and a Broadcast and Unknown Server (BUS).

The capacity of the Catalyst OC-12 adapter for handling LANE traffic is nominally 400 kpps, which is consistent with the interface speed.

Catalyst 6500 does not support translational bridging nor token-ring ELAN, so we must rely on an ATM router/bridge to route/translate between Ethernet and token-ring. Fortunately, this function is readily available.

For the IP traffic, we can distribute the load of translation to the MSS clients in the IBM 8270 and short-cut route with the MPOA protocol to the MPOA client in the Catalyst 6500.

In smaller networks, customers have sometimes saved the cost of the IBM 8270 MSS client UFC and purchased only the ATM Uplink UFC. In this case, the MSS or a Cisco router may be used to do the routing.

Note that this may require additional router capacity. But it is probably more advantageous to buy an extra router than to replace the ATM Uplink UFCs with MSS client UFCs. You may use an existing MSS or a Cisco router with an OC-3 adapter as a “router-on-a-stick” installing a single physical interface in the router and provisioning it with multiple "virtual interfaces."

A Cisco router with a fully configured IOS Version 12 has all the functions of the MSS with a few exceptions such as intelligent broadcast reduction (IBM proprietary function). Although a Cisco router can have full LECS/LES/BUS/MPS capability, customers are probably inclined to leave these functions to the MSS at this time. However, if there is a heavy load of translational bridging, a Cisco 7200 as an one-armed router (OAR) is an excellent choice.

IPX is not supported by the Catalyst MPOA client at this point in time. Therefore IPX traffic must be routed by an ATM router. Non-routable traffic obviously must be bridged. As mentioned, this is readily handled by the MSS or for example, a Cisco 7200.

Tip

Parallel bridges in an Ethernet environment can be used to provide redundancy. If more than one MSS or Cisco router provide translational bridging, the spanning tree protocol (STP) must be invoked to avoid loops or duplication of frames. This puts a limit on the amount of bridged traffic that can flow between the Ethernet and the token-ring LANs. The limit is determined by the bridging capacity of an MSS or a Cisco router. This is normally not a problem because non-routable traffic will usually have other constraints. Employing the intelligent broadcast reduction function of the MSS can also reduce the amount of traffic to be bridged.

4.1.3 Future phases

As mentioned earlier in this redbook, it seems very probable that Ethernet will be the standard interface for all digitized transports in the not-too-distant future. ATM will still play a significant role in the wide-area network, but much of the equipment on customer premises will likely present the user with an Ethernet interface.

For this reason, the users of ATM backbones may want to plan for the removal of the ATM switches from their LAN. In some cases, this may be accomplished quickly, while in other cases it would not be possible to do so in the foreseeable future.

Cost savings on operations or lack of skills to maintain the ATM backbone may make it desirable to remove the ATM switch and use a plain translational bridge or Cisco ISL encapsulation on Cisco routers and switches, depending on requirements.

If the ATM backbone is used for legacy telephony or circuit-switched video conferencing, it is probably advantageous to keep it until the time when all the attached equipment has been depreciated and replaced by newer equipment with an Ethernet interface.

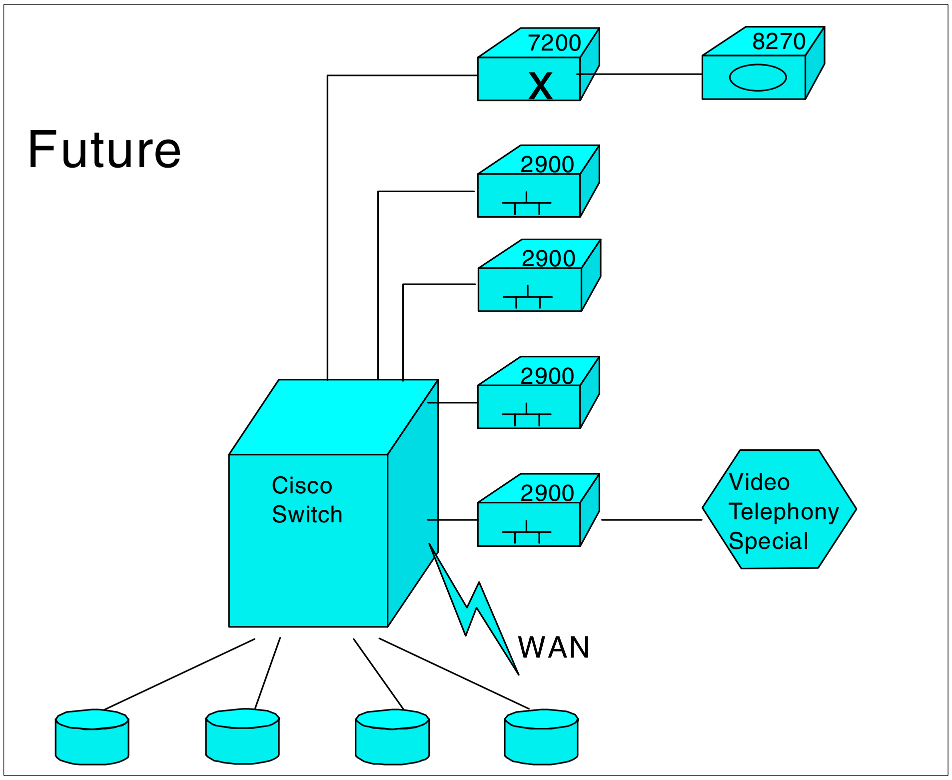

Figure 46. Ethernet backbone

Such replacement can now happen since we now have a solid Ethernet backbone capable of handling heavy volumes of traffic and we also have the functionality to prioritize and handle Quality of Service. In cases where it will not be cost effective to upgrade older equipment, keep the ATM backbone while the old, existing video equipment and switchboards are still in operation.

Technology develops continuously and changes over time. Ethernet will continue to change providing better functionality and services. This may well push our scenario towards what is shown in Figure 46.

4.2 Interoperability testing

In December 1999, IBM and Cisco commenced extensive testing of interoperability between IBM and Cisco ATM LAN switches. Phase 1 of these tests has been completed. Please contact your IBM or Cisco representative

to get the latest information about the interoperability tests, and for instructions on submitting requests for new interoperability tests.

4.3 Example of adding a Catalyst 5500 to an IBM 8265 ATM backbone

In our test configuration, we have an IBM 8265-based backbone with an IBM 8270 token-ring edge switch. We want to add a Catalyst 5500, with an ATM LANE module, configured with an emulated Ethernet LAN and using MPOA to create a shortcut route between a token-ring VLAN and an Ethernet VLAN.

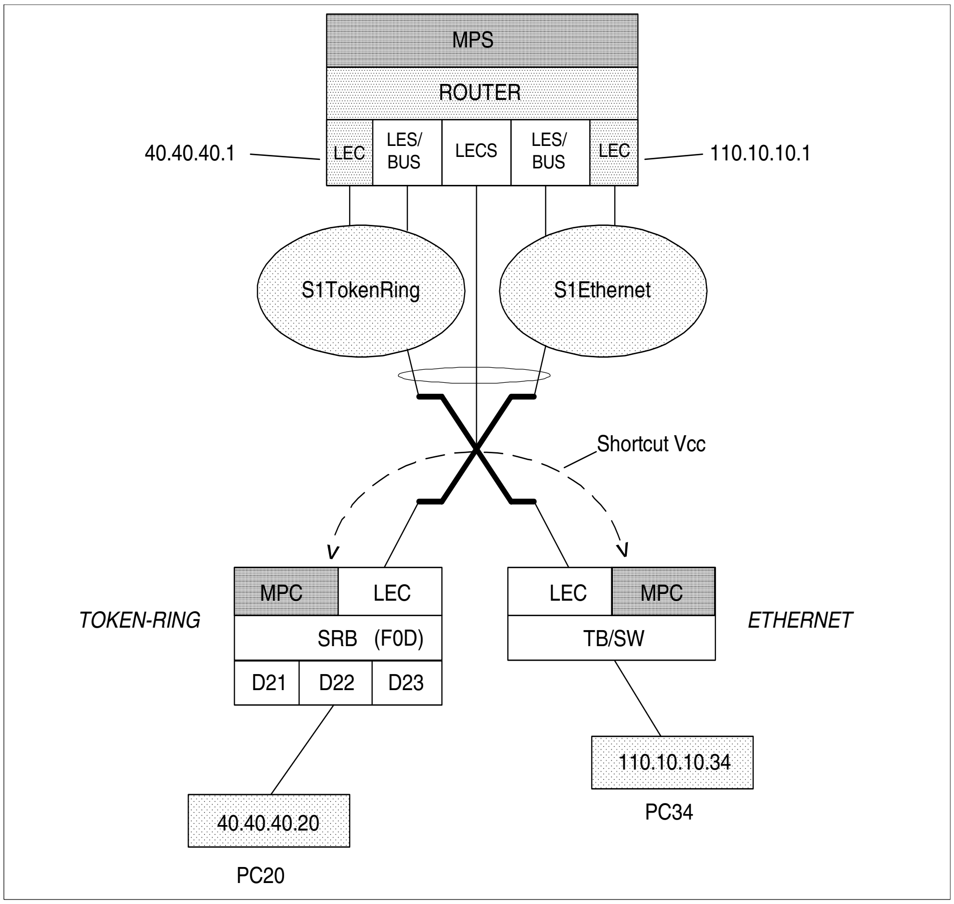

Figure 47. Shortcut between token-ring MPC and Ethernet MPC

The logical configuration is shown in Figure 47 and the physical configuration in Figure 48 on page 77. The MSS blade in the IBM 8265 acts as an MPOA server. The MSS client UFC of the IBM 8270 is one of the MPOA clients. The

DUAL-PHY OC-3 blade in the Catalyst 5500 switch implements the other MPOA client.

In Appendix A, “IBM 8265 configuration for the MPOA test” on page 119, we have included displays of some `show` commands showing some of the configuration of the IBM 8265 switch. The IBM 8270 was attached to port 14.3, and the Catalyst 5500 was attached to port 16.3.

The interoperability test consisted of the following four major steps:

1. Configuration of IBM 8265 MSS (MPOA Server)
2. Configuration of IBM 8270 MSS client (MPC)
3. Configuration of Catalyst 5500 dual port OC-3 ATM module with MPC
4. Verification of shortcut routing taking place

The environment we are building is fairly complex, and there are several pieces that must fall into place for the interoperability test to be successful. However, we would like to assure you that we succeeded in what we set out to do. We attribute this to a strong standard and skillful product implementations.

Here are the essential features that must be understood and properly configured for interoperability:

a. UNI signalling.

   It is recommended that you hard code the UNI versions when working in a mixed vendor environment. The OC-3 adapter in the 8265 switch is set to auto, in order for the adapter to find out what UNI version the client is running. The OC-3 interface in our 8270 switch is set to V3.0, and the interface in the Cisco 5500 Switch is set to V3.1. The 8265 switch negotiates the signalling version to be used between the connected devices and will show V3.1 for the connection to 5500 and V3.0 for the 8270.

   Note

   It is recommended that you hard code UNI versions when working in a mixed environment. It is also recommended that you set all the UNI versions to the same fixed value to avoid conversion between different UNI versions.

   The use of UNI 3.0 here is for test purposes only.

b. Joining the ELAN named “S1Ethernet”.

   The 5500 LEC can use ILMI to get the LECS address from the ATM switch. Thereafter go through validation with the LECS on the policy ELAN name to get the LES address, and finally join the LES/BUS for S1Ethernet. The IBM 8270 MSS Client must go through the same process to join the ELAN “S1TokenRing”.

c. Enable multiple IP connections between both the token-ring and Ethernet workstations.

d. MPOA.

   The MPS has to recognize both MPCs and establish communication for the MPOA to work. The MPCs in the 5500 and MSS client have to work together as well (for example signalling, etc.).

e. The token-ring to Ethernet address translation and frame fragmentation must be addressed. In this example the MSS client does the frame fragmentation

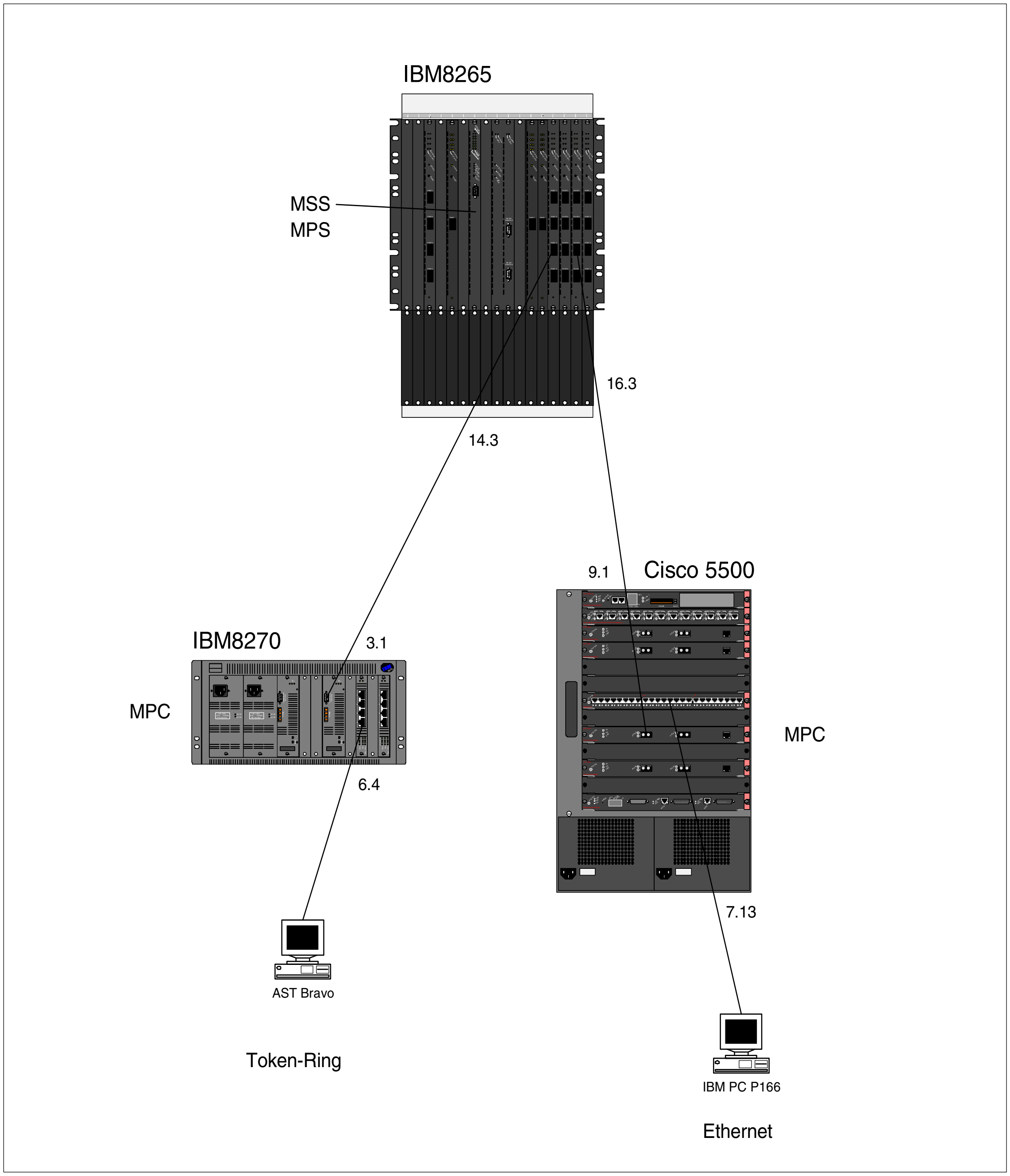

Figure 48. The physical test setup

The MSS client in the 8270 token-ring switch can be configured in several ways. For this test, we created three domains, interconnected via an internal source route bridge. That forces the MSS client to create a RIF field. See Figure 47 on page 74 for the logical configuration and an overview of the test.

The configuration of the involved devices can be done in several ways. For the MSS server and the MSS client, the IBM Configurator tool was used. For the Cisco 5500, the IBM 8265, and the IBM 8270, the configurations were made with the native Command Line Interface (CLI) connected via a VT100 terminal emulator attached to the service ports.

4.3.1 MSS Server configuration

We used the specific configuration tool for the MSS Server, V2.2 PTF 4 as seen in the copyright notice in Figure 49. Remember to check that the configurator version matches the MSS code version. Otherwise you may run into unexpected results.

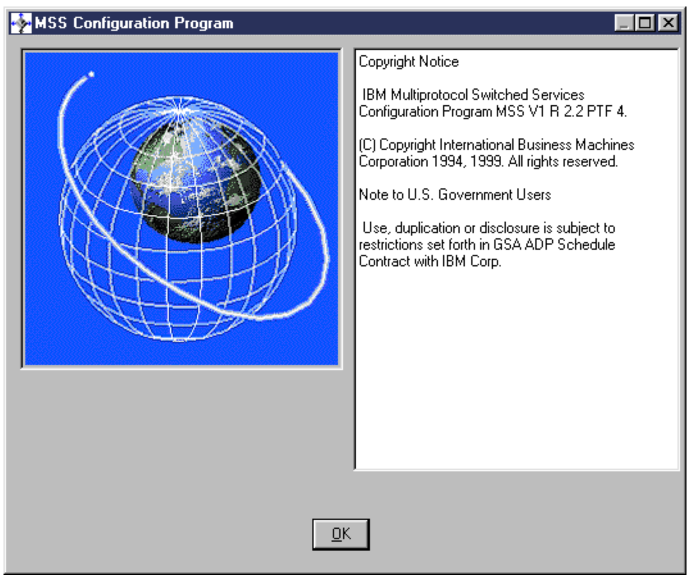

Figure 49. Start window for the MSS Server Configurator

The next pages show the most important part of the MSS configuration for this test. We show how to configure the device interfaces, LAN Emulation and the MPOA parameters. The reader is assumed to have a basic knowledge of configuring MSS.

Tip

The redbooks *MSS Release 2.1 Including the MSS Client and Domain Client*, SG24-5231, *Layer 3 Switching Using MSS and MSS Release 2.2 Enhancements*, SG24-5311-00 and *ATM Configuration Examples*, SG24-2126, are excellent sources of detailed information on the MSS products.

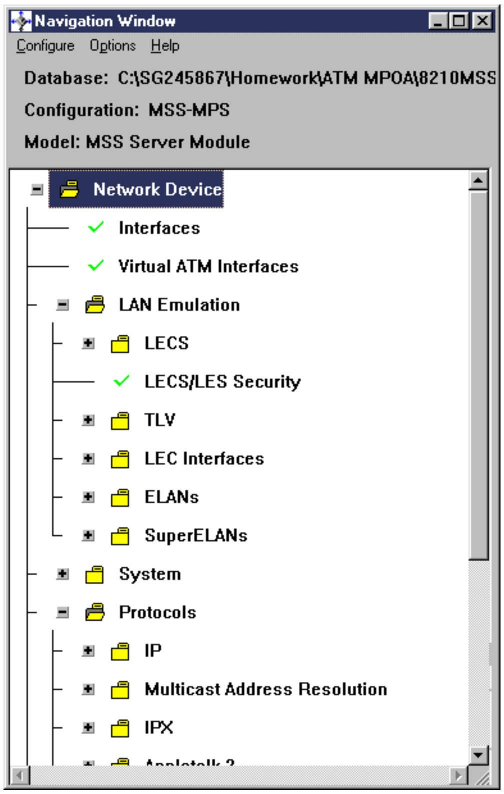

Figure 50. MSS Configurator tree structure

Figure 50 shows the MSS Configurator Navigation Window. The configurator is designed in a tree structure for easy navigating. It starts with the ATM interface, adds LANE services, and ends with protocol configuration.

The Configurator for MSS client is similar but with a reduced command set, in agreement with the client's functionality.

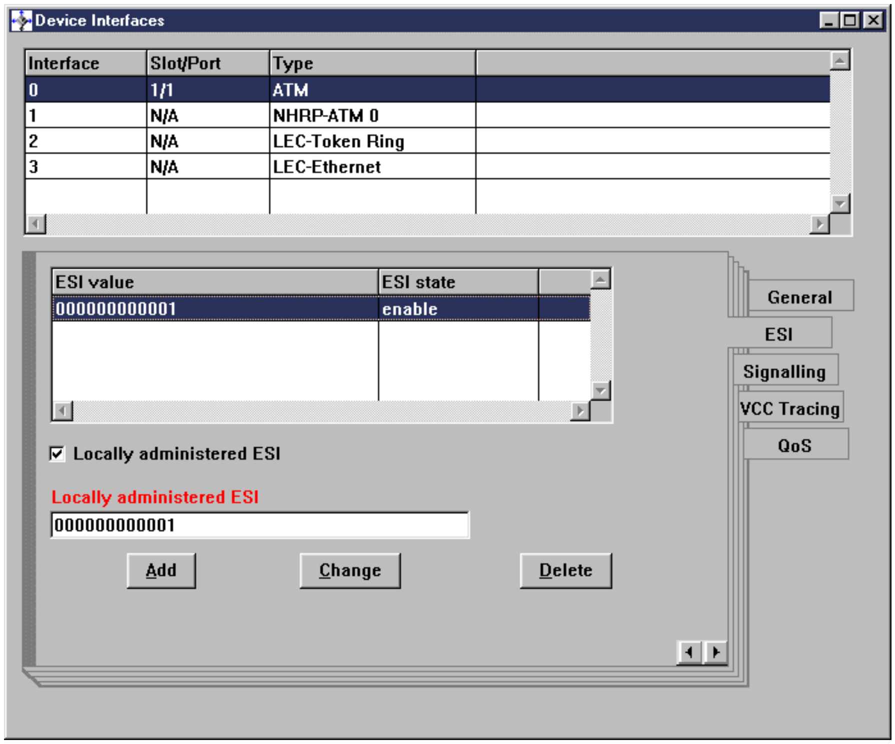

Figure 51. Configuration of MSS ESI address

First the ATM interface is given an ESI address, and we used a locally administered address for easy recognition of the MSS services. On the Signalling tab, the interface is set for ATM Forum-compliant UNI 3.0. Although UNI 3.0 is used in this example, the recommended UNI version is UNI 3.1.

Hereafter the LECS is created as shown in Figure 52.

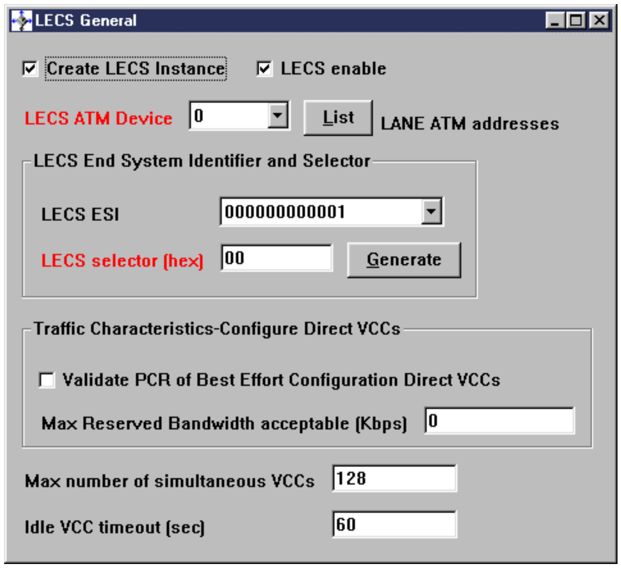

Figure 52. LECS General

The LECS needs a selector byte, which is generated to be 00. The LECS is assigned the ELAN name as policy and enabled as shown in Figure 53.

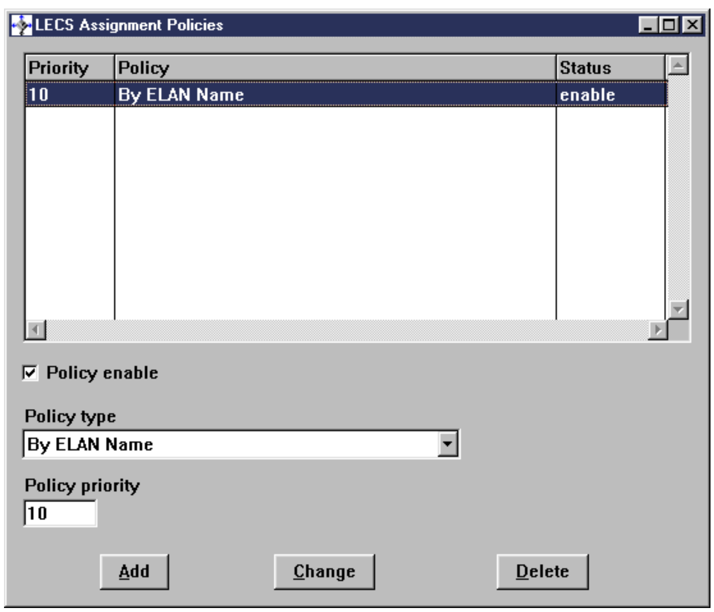

Figure 53. LECS Assignment Policies

The LECS has a security function. By creating the LECS/LES Interface, a LEC has to be validated by the LECS, to join a LES and become a member of the ELAN. The criteria for validation is the LES Policy.

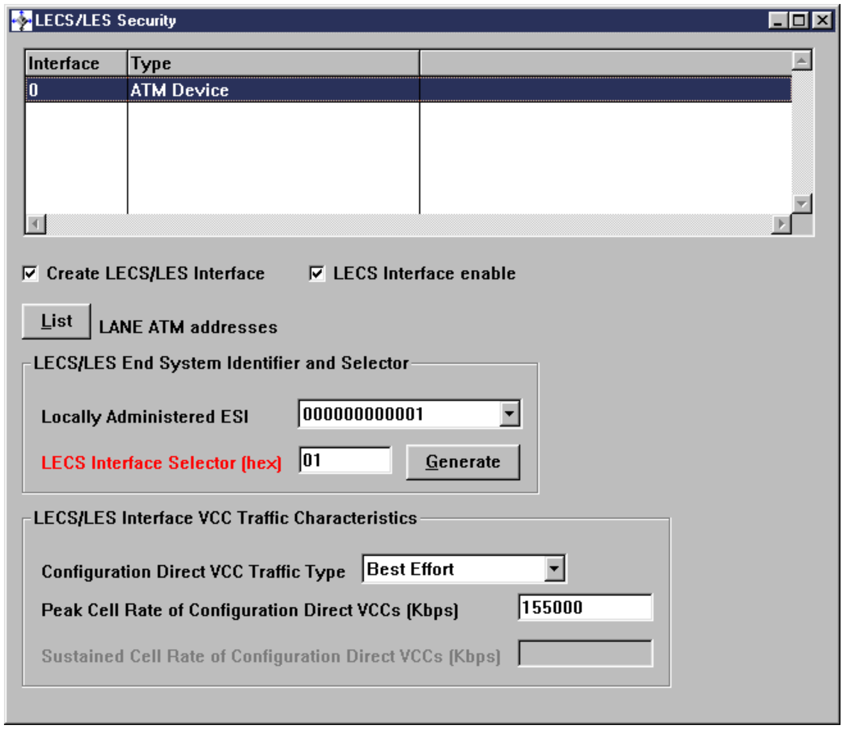

Figure 54. Creating LECS/LEC Security

By creating this feature, we force both of the LECs to connect the LECS using the validation of the policy ELAN name (S1Ethernet and S1TokenRing). We wanted the Cisco LEC to join our ELAN using ILMI to get the LECS, and then the ELAN name S1Ethernet to get the LES ATM address.

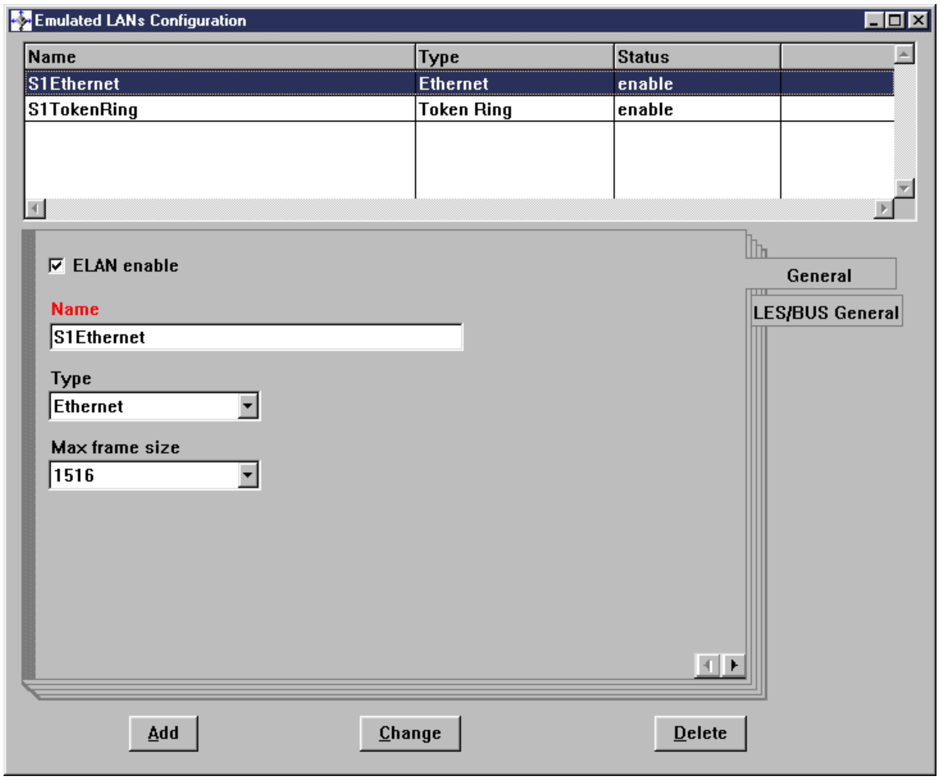

Figure 55. Emulated LANs Configuration

Now we create the two ELANs, S1Ethernet and S1TokenRing. Figure 55 shows the created ELANs and the General tab for S1Ethernet. S1TokenRing max frame size is set at the default value 4544. As long as the MSS will be doing the IP routing between the two ELANs, the MSS Server will do the fragmentation of frames coming from token-ring and routed to Ethernet. Later when the shortcut is established, the fragmentation will be done by the MPC client in the 8270 Switch.

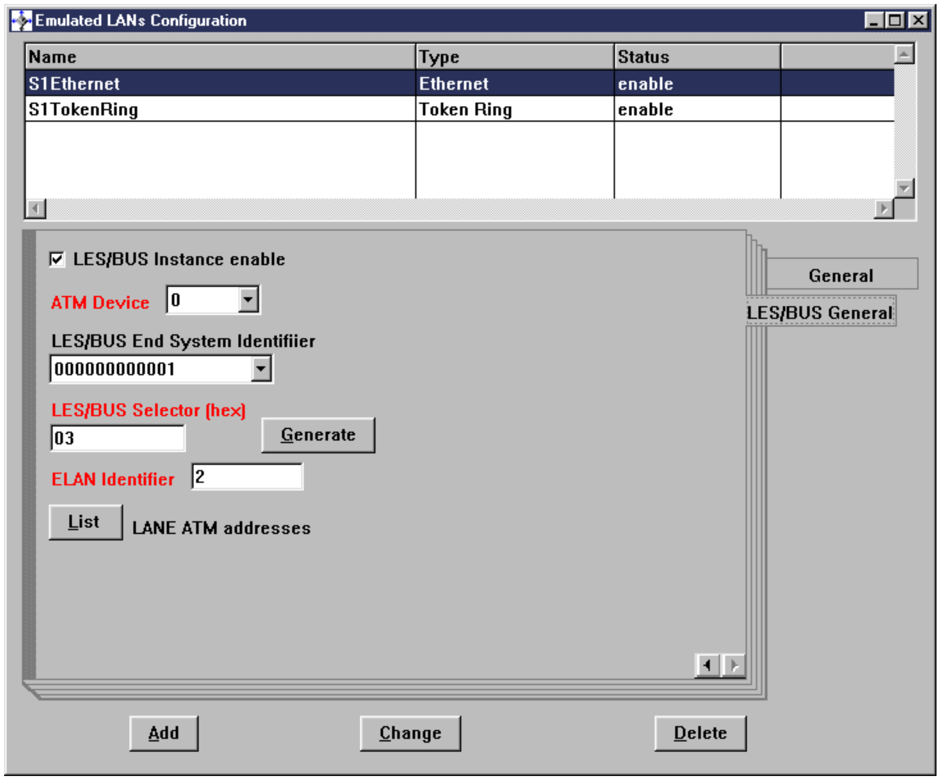

Figure 56. LES/BUS End System Identifier (ESI)

On the LES/BUS General tab the two ELANs are assigned a LES/BUS End System Identifier. We are using the locally administered address as shown in Figure 56. S1Ethernet is given the selector 03 and the ELAN identifier 2. S1TokenRing is given the selector 02 and the ELAN identifier 1.

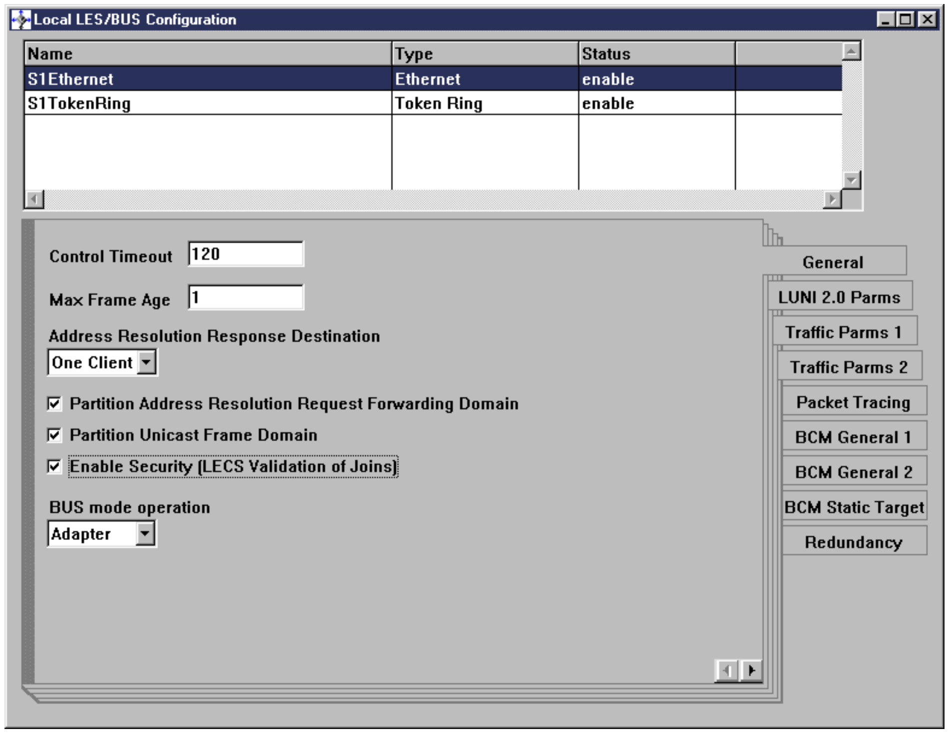

Figure 57. Enabling access security

In the Local LES/BUS Configuration window (Figure 57), we enable security, which forces the LECs to be validated by the LECS before they are able to join the ELAN. This security feature prevents a LEC from joining the LES directly without policy validation.

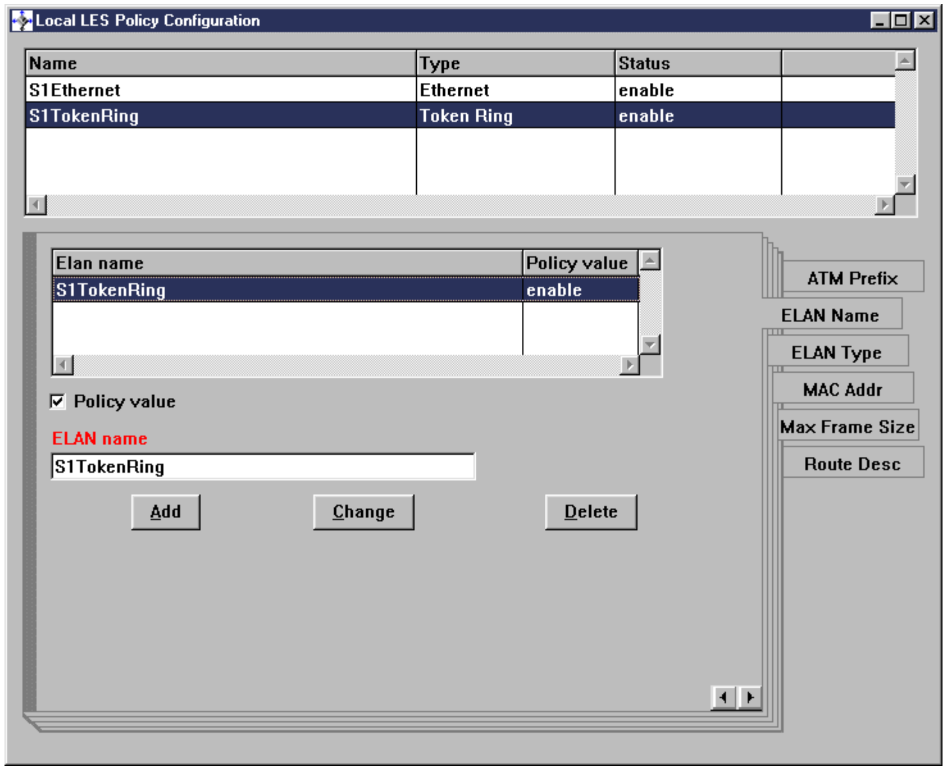

Figure 58. Local LES Policy Configuration: S1TokenRing

In Figure 58 we can enable LES policies. From the tabs, the individual policy types can be selected and enabled. For the test we assigned only the ELAN name; Figure 58 shows the ELAN name enabled. We enabled the policy value, wrote the ELAN name, and added the parameter to the LES. The same procedure was repeated for Ethernet ELAN S1Ethernet.

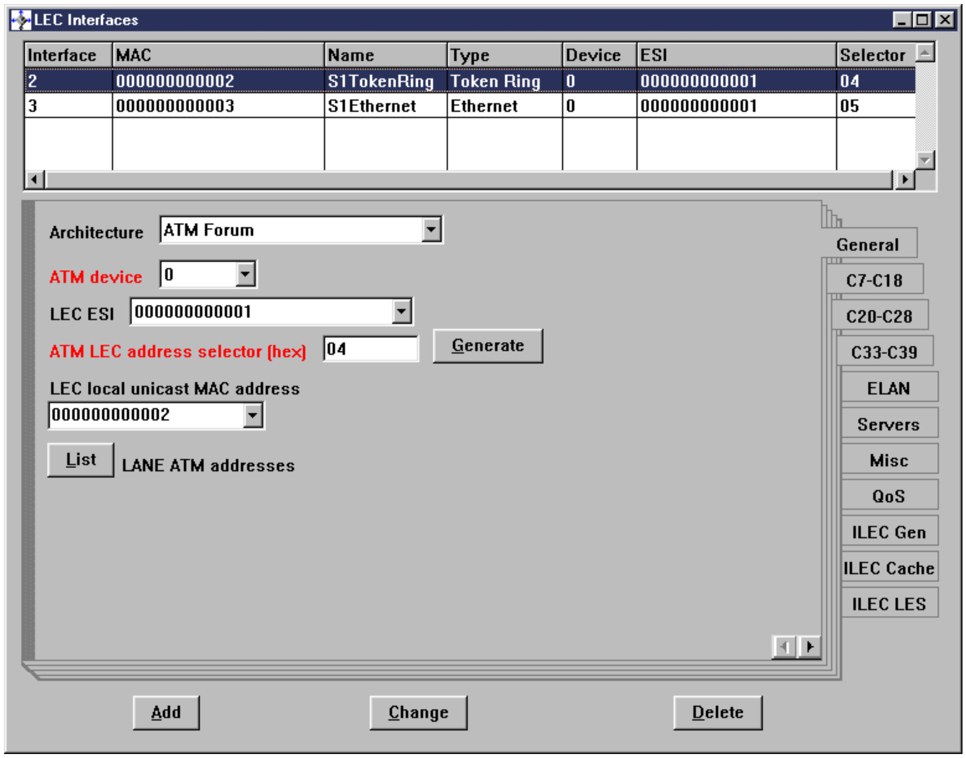

Figure 59. Creating a LEC

Figure 59 shows the creation of a LEC interface. The MSS must act as a Router between the token-ring and the Ethernet ELANs, as well as provide the MPS services for our two ELANs. Thus we must add a LEC to each ELAN. Using 000000000001 as the ESI address, S1TokenRing is given a selector 04, and S1Ethernet selector 05. Again we chose to leave as many parameters as possible as the default, and went directly to the ELAN tab for defining the LEC as shown in Figure 60.

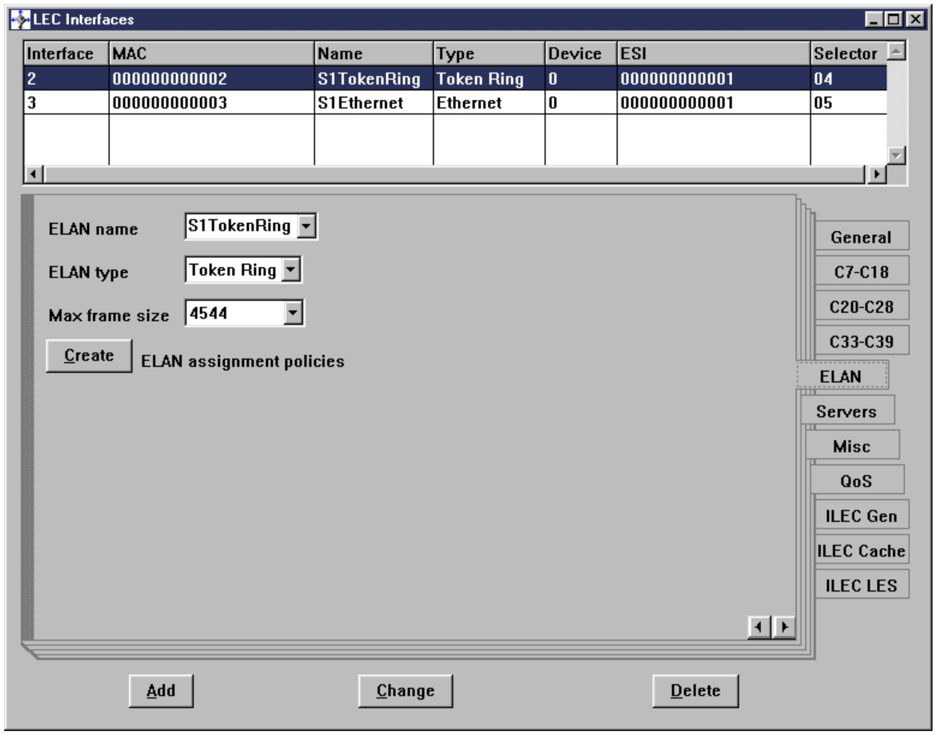

Figure 60. LEC Interfaces: ELAN

In Figure 60 we select the ELAN name for the LEC. From the pull-down menu we choose S1TokenRing or S1Ethernet respectively. Choose the ELAN type which sets the maximum frame size as the default for token-ring and Ethernet. Remember to click the **Add** button to set the new parameters before leaving this window.

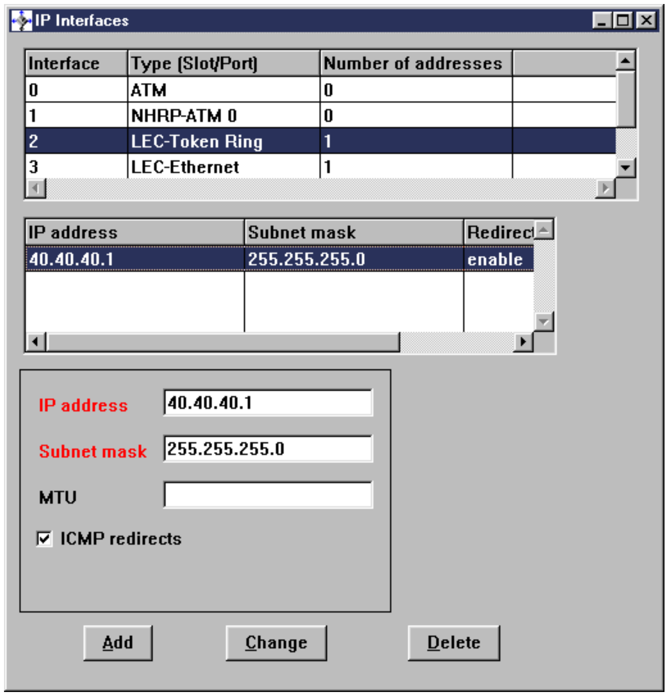

Figure 61. MSS token-ring LEC IP address.

In Figure 61 we assign the IP address to the token-ring ELAN, and enable the LEC as a router interface. Address 40.40.40.1 will be the Default Gateway for our token-ring Client during the test. Click **Add** to add the IP address.

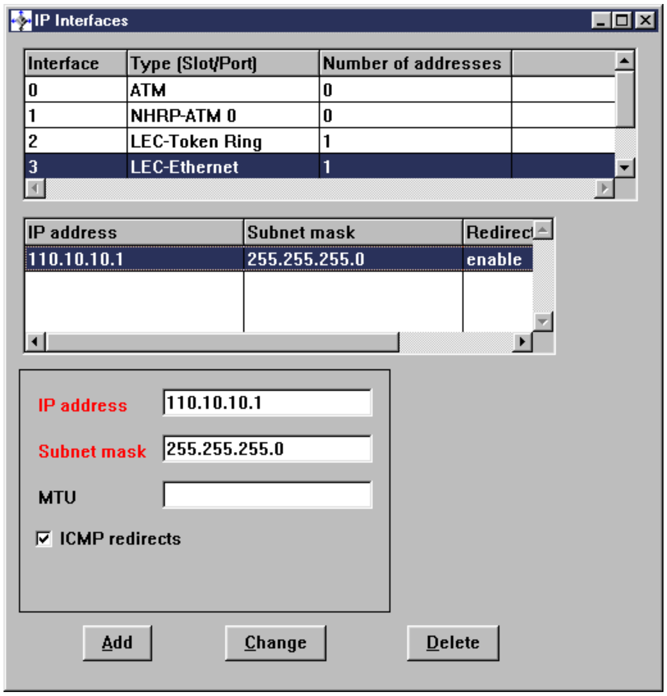

Figure 62. MSS Ethernet LEC IP Address

Figure 62 shows adding 110.10.10.1 as the IP address for the Ethernet LEC. Now we have a router with a connection into the to ELAN. 110.10.10.1 will be the default gateway for the Ethernet. Only the two LECs are assigned IP addresses.

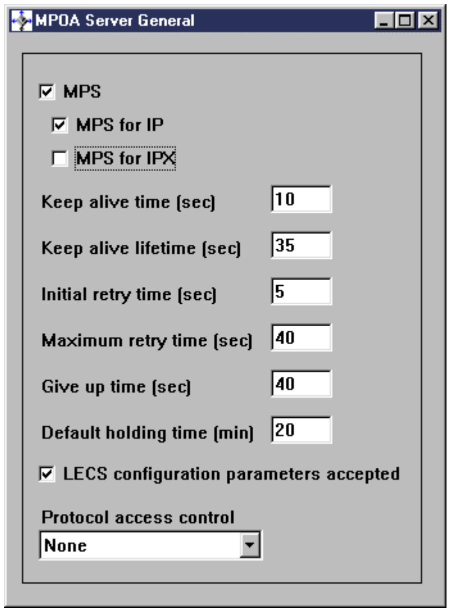

Figure 63. Enabling MPS and MSS.

In Figure 63 we configure the MPS Server. By default both IP and IPX are enabled in the V2.2 MSS Configurator. We will test only the IP. Checking **LECS configuration parameters accepted** means that the default parameters may be replaced by parameters from the LECS.

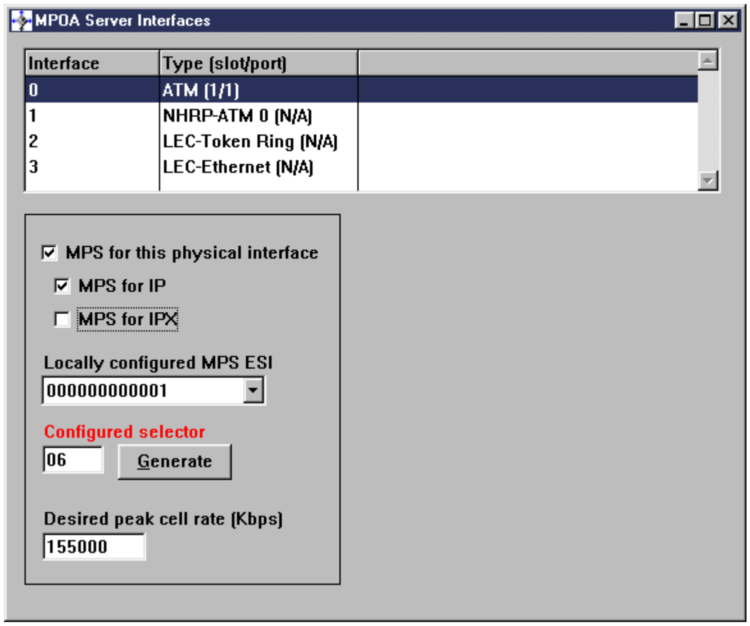

Figure 64. Configuring MPS ESI address and supported protocol

Since the MPS function is now turned on, we will enable the services for the individual network interfaces. First we do it on the physical ATM interface using our ESI address with the selector value of 06. We enable MPS for IP. In Figure 65 and Figure 66 the MPS services is enabled on the LEC interface for our Ethernet and token-ring, and again the MPS for IP but not for IPX. Now the MSS Server configuration is completed.

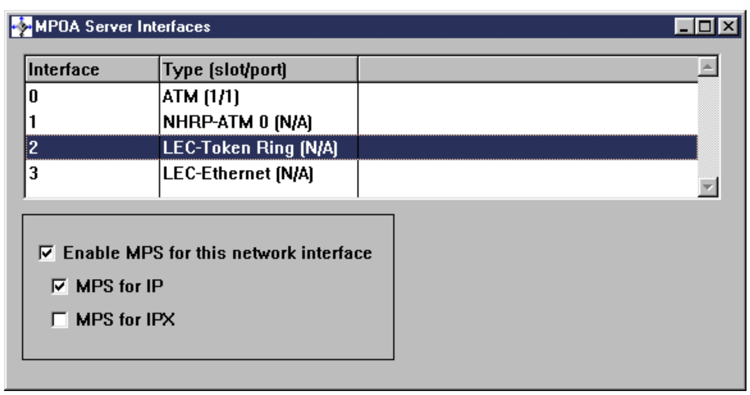

Figure 65. MPS token-ring interface

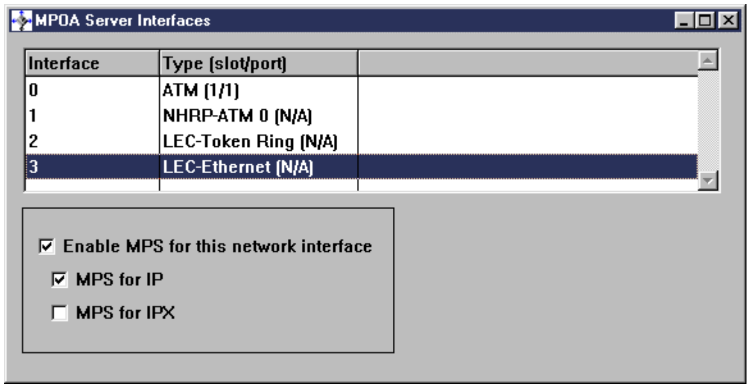

Figure 66. MPS Ethernet interface

4.3.2 MSS client configuration

As shown in Figure 67, the configuration of the 8270 Token-Ring Switch consist of three domains: an SRB bridge, MPC client and the ATM interface. The configuration of the legacy token-ring switch is not shown in this chapter, but like the 8265 it is considered basic. We created the three domains and assigned individual ports. All other definitions were left at their defaults. For configuration of the MSS client, the IBM Multiprotocol Switched Services Client Program MSSC V1 R2.2 PTF 3. was used.

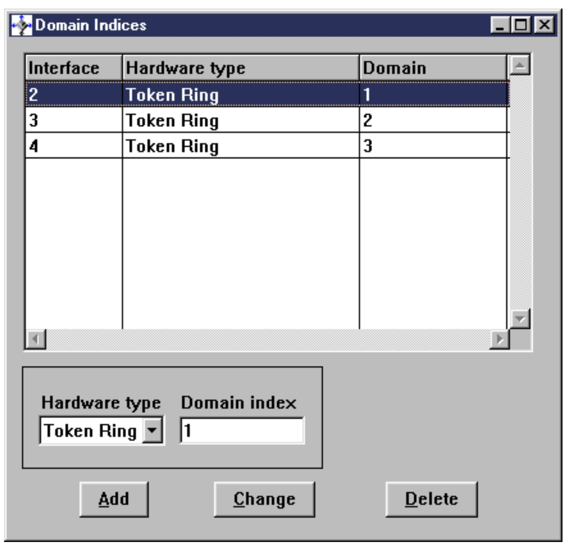

Figure 67. Add token-ring interface to base unit domain

In the Domain Indices window we first add token-ring interfaces to connect the MSS client to the domains already set up in the base switch. We create three interfaces knowing that the test would need only two domains to be configured. The hardware type is selected from the pull-down menu and the domain index is set equal to the domain index in the base configuration. The default domain is index 0.

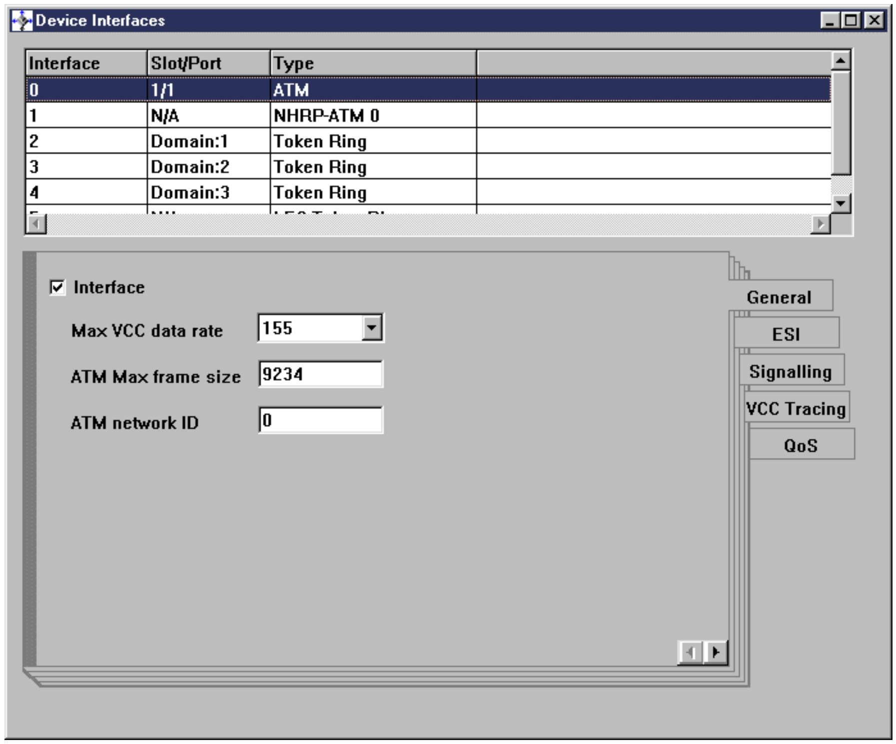

Figure 68. Enabling MSS client ATM Interface

In the Device Interfaces window, shown in Figure 68, we now set up the ATM interface of the MSS client. The network ID is 0. The interface 1, NHRP-ATM 0 is set by default but not used in this test.

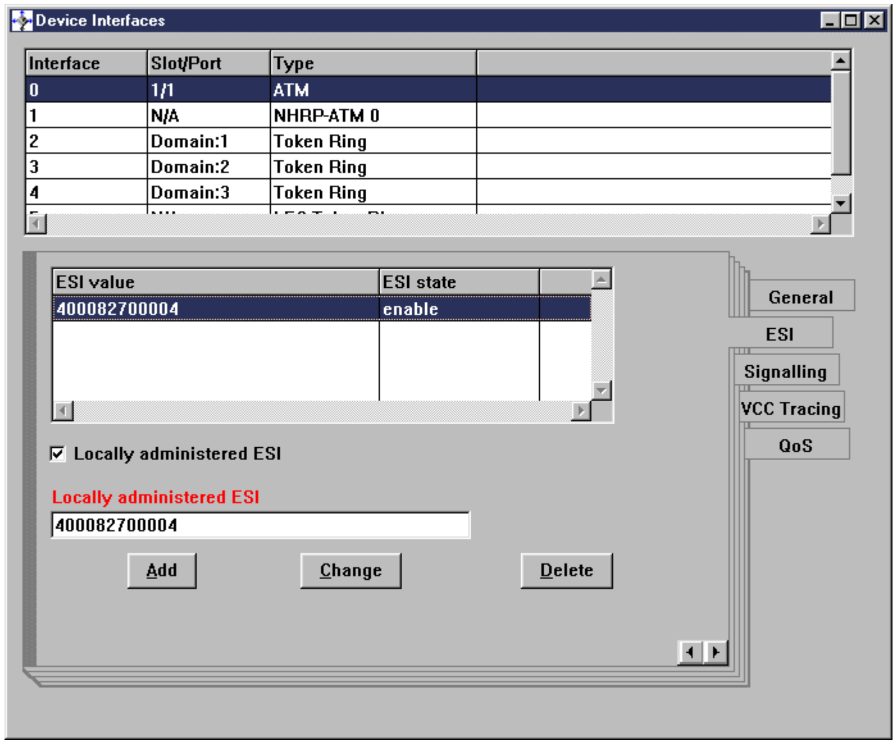

Figure 69. Adding locally administered ESI

In the ESI tab, we enable the locally administered ESI, and set it to 400082700004. In the Signalling tab, not shown here, we set the signalling protocol to UNI 3.0. The rest of the parameters were left at their defaults.

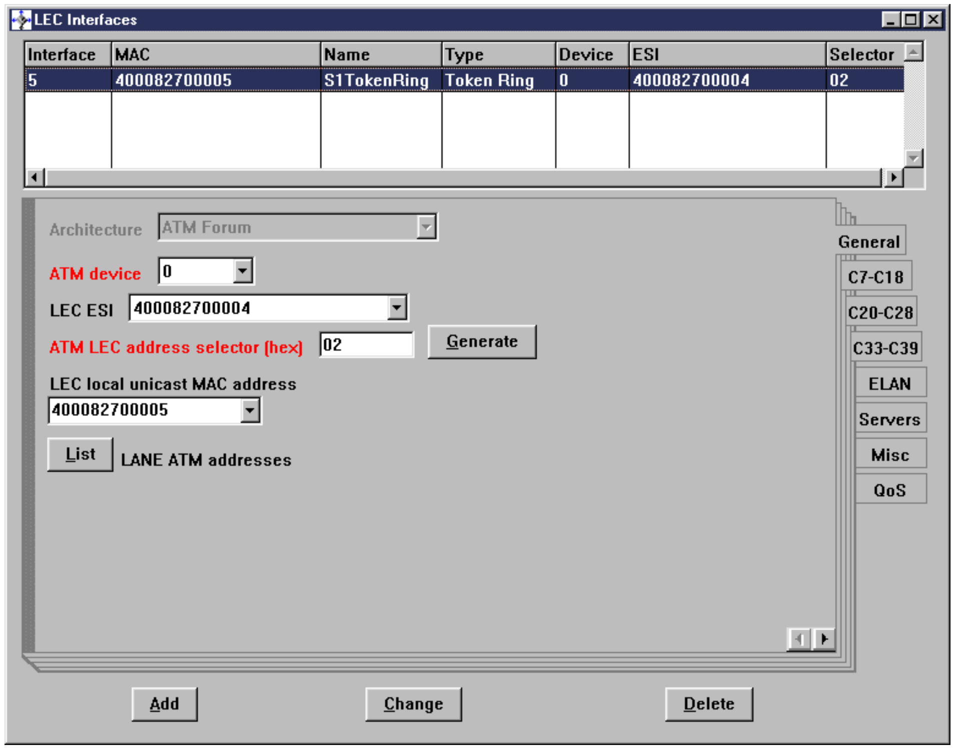

Figure 70. Configuration of LEC interface

From the Navigation Window (see Figure 50 on page 79) we chose **LAN Emulation** to set up the LEC. From the General tab we selected **ATM device 0,** using the ESI we chose for the ATM interface 400082700004 and generated selector 02. The new LEC was given a local MAC address 400082700005. In the ELAN tab we added the ELAN name and ELAN type leaving the max frame size as the default 4544. The ELAN name, S1TokenRing, is shown in Figure 70. In the Server tab, we enabled LECS AutoConfiguration, so the MSS client LEC could use ILMI to get the LECS address. ELAN policy was set to join the LES for ELAN S1TokenRing.

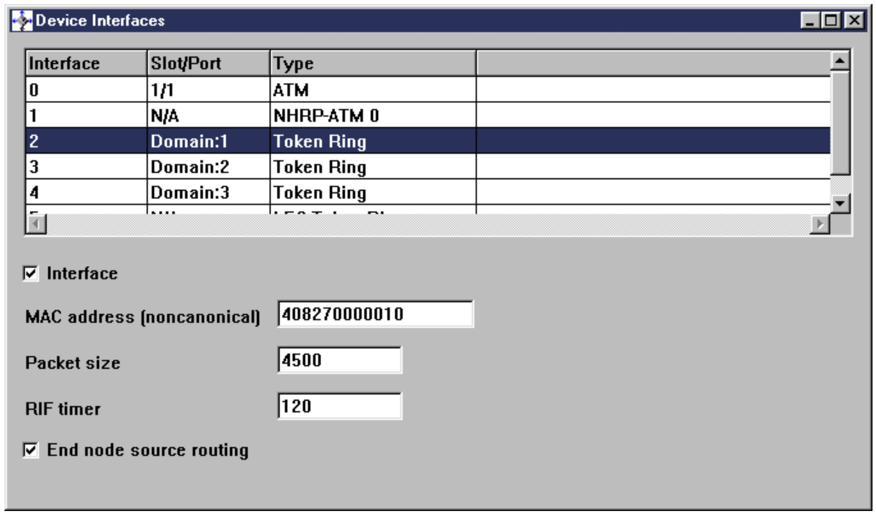

Figure 71. Device Interfaces

In the Device Interfaces window, shown in Figure 71, each interface with a domain associated was given a MAC address:

- Interface 2, Domain:1, Mac 408270000010
- Interface 3, Domain:2, Mac 408270000011
- Interface 4, Domain:3, Mac 408270000012

To test frames with a RIF field involved, both the domain interface and the LEC interface were enabled for end node source routing, as we activated the source route bridge in the MSS client.

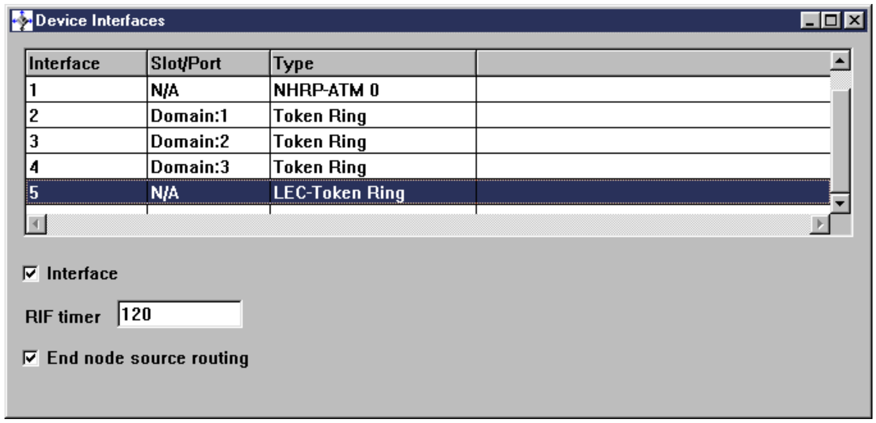

Figure 72. Configuring LEC Interfaces Source Routing

To prevent the MSS client from starting to route IP, no IP addresses were assigned to the interfaces. Therefore we enabled the TCP/IP host services (shown in Figure 73) so we could communicate with the client via the IP host address 40.40.40.134. The default gateway was set to 40.40.40.1, which is the S1TokenRing IP address on the MSS Server.

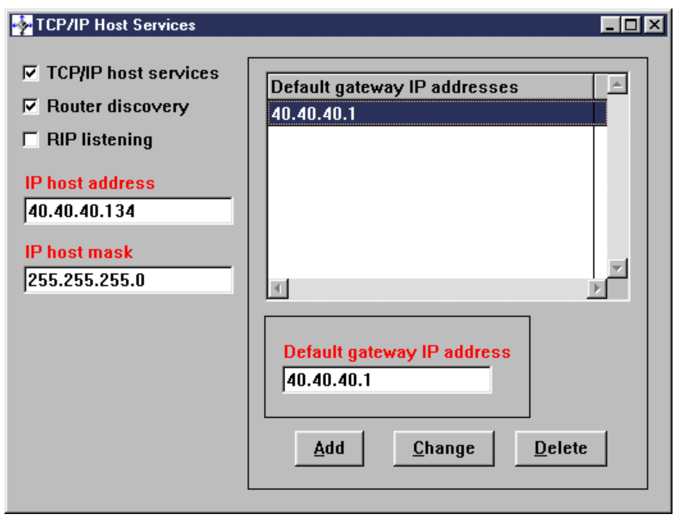

Figure 73. Enabling TCP/IP Host Services

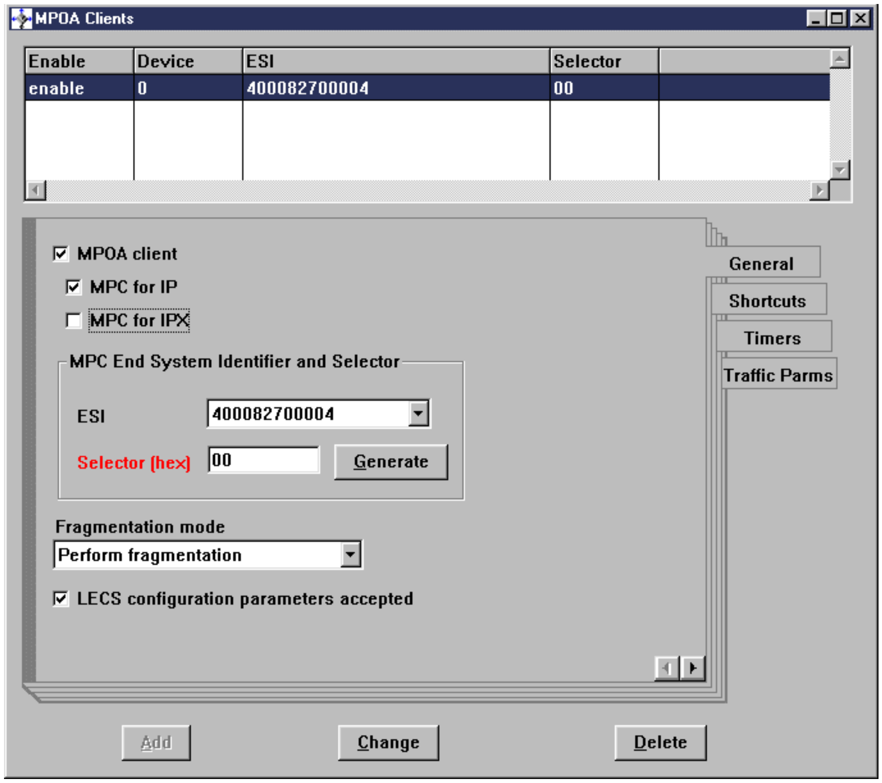

Figure 74. Enabling MPC support on MSS client

From the Navigation Window (see Figure 50 on page 79) click **Protocol -> MPOA/NHRP -> MPOA Client**. We enabled the client, plus MPC for IP. We used our locally administered ESI and generated selector 00.

Since the shortcut was to be between token-ring and Ethernet, we needed a frame fragmentation, since the two types of frames have different MTU sizes. As long as the MSS server is doing the routing, it does the fragmentation as well. With the shortcut established, one of the MPCs has to do the fragmentation and that was to be the MSS client.

The LECS configuration parameters accepted box is checked by default. This parameter indicates whether configuration parameters from the LECS will be accepted by MPC.

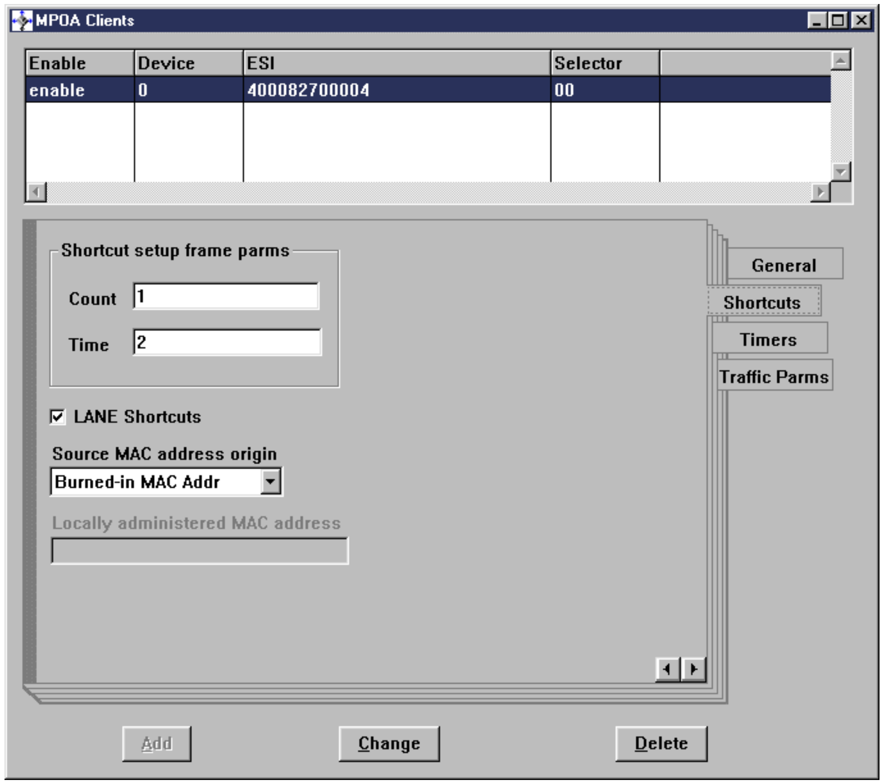

Figure 75. Config of MPC client shortcut

In Figure 75, we enabled **LANE Shortcuts**, and set the shortcut setup frame parameters. For this test, we set the Count to 1 and the Time to 2. Since we used the `ping` command during the test, we needed the shortcut to be established by pinging, with one packet in less than two seconds. Other timing parameters was left at the defaults.

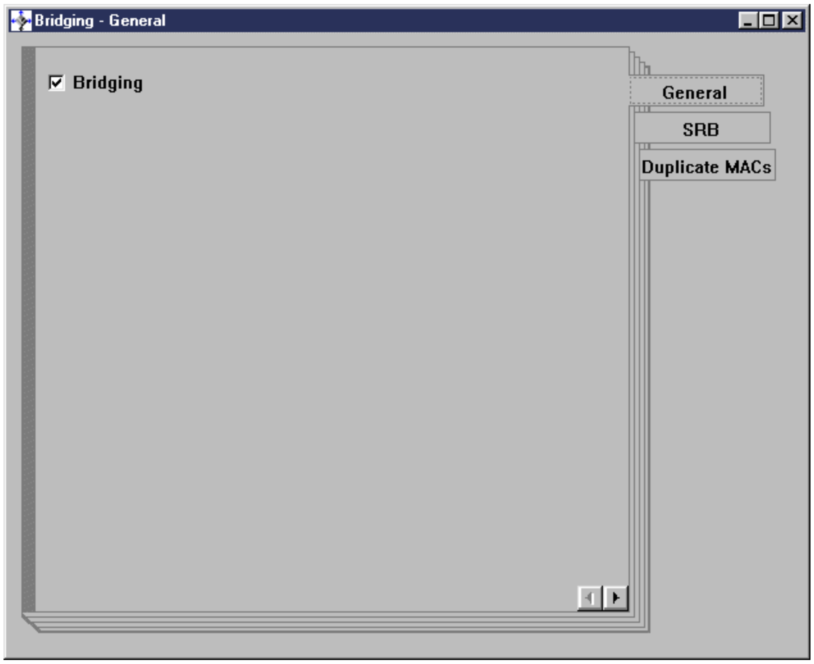

Figure 76. Enabling bridging in MSS client

In Figure 76, the internal SRB bridge in the MSS client is enabled.

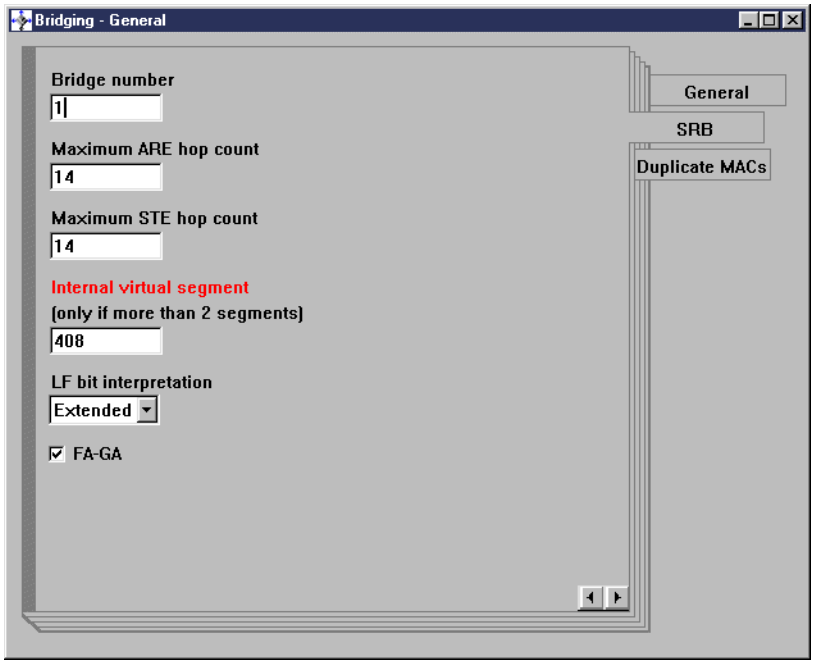

Figure 77. Internal virtual segment

Since we have more than two segments, we need to configure an internal segment. This is done in the Bridging - General window, using the SRB tab. The bridge number is set to 1, since we do not have parallel bridges. Internal virtual segment is set to 408.

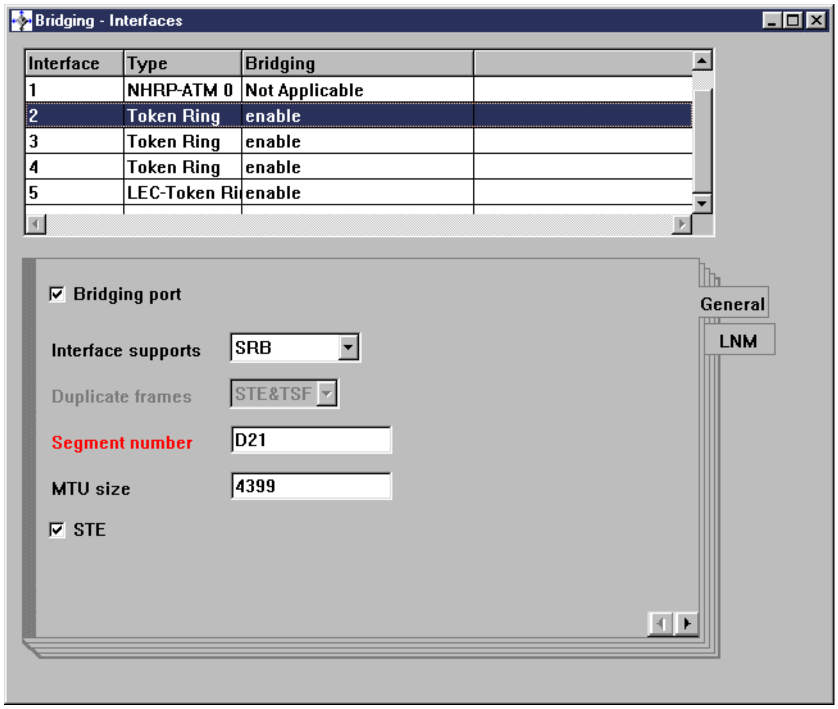

Figure 78. Adding segment numbers to bridge interfaces

In Figure 78 we enable interfaces for SRB, and add a segment number to each. We enable interfaces 2, 3, 4, and 5, the last is our LEC. The segment numbers are set as follows:

- interface 2 - segment number D21
- interface 3 - segment number D22
- interface 4 - segment D23
- interface 5 (the LEC) - segment F0D

See Figure 79. Now the MSS client configuration is complete.

The route from the legacy token-ring LAN to the legacy Ethernet would be as follows: frame from local segment D21 -> bridge 1 -> segment 408 -> bridge 1 -> segment F0D (S1TokenRing ELAN) -> MSS Router -> S1Ethernet.

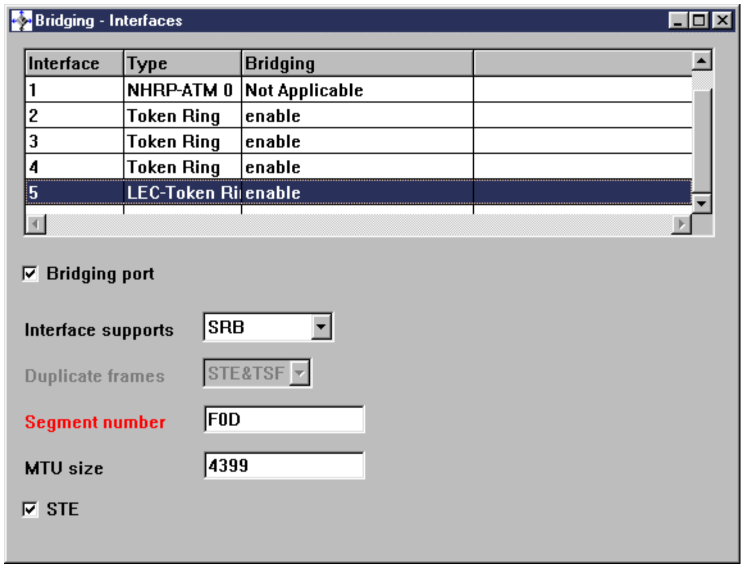

Figure 79. Adding segment numbers to the LEC

4.3.3 Configuring the Catalyst 5500 MPOA client

Here is how we have configured the Ethernet MPOA client in the Catalyst 5500 to set up a shortcut route to the IBM 8270 token-ring switch.

The configuration process has three major steps:

1. Creating a VLAN
2. Building the LAN Emulation Client
3. Configuring the MPOA client

4.3.3.1 Creating a VLAN

A Catalyst switch always belongs to a VLAN Trunking Protocol (VTP) domain. We must name the VTP domain. This is accomplished using the `set vtp domain cisco` command. The `show` command displays the defaults.

```
Cisco Systems Console

Enter password:
cat5500-sup enable

Enter password:
cat5500-sup (enable) set vtp domain cisco
VTP domain cisco modified

cat5500-sup (enable) show vtp domain
Domain Name                     Domain Index VTP Version Local Mode  Password
-------------------------------- ------------ ----------- ----------- ----------
cisco                                1            2           server      -

Vlan-count Max-vlan-storage Config Revision Notifications
---------- ---------------- --------------- -------------
19         1023             13              disabled

Last Updater    V2 Mode  Pruning  PruneEligible on Vlans
--------------- -------- -------- -------------------------
10.10.10.248    disabled disabled 2-1000
```

Figure 80. Creating domain “Cisco”

Next we define VLAN 11 to port 3 and port 13 on module 7.

```
cat5500-sup (enable) set vlan 11 7/3,7/13
VLAN  Mod/Ports
---- -----------------------
11    7/3,7/13

cat5500-sup (enable) show vlan 11
VLAN Name                             Status    IfIndex Mod/Ports, Vlans
---- -------------------------------- --------- ------- ------------------------
11   VLAN0011                         active    1599    7/3,7/13

VLAN Type  SAID       MTU   Parent RingNo BrdgNo Stp  BrdgMode Trans1 Trans2
---- ----- ---------- ----- ------ ------ ------ ---- -------- ------ ------
11   enet  100011     1500  -      -      -      -    -        0      0
```

Figure 81. Define VLAN 11, adding ports 3 and 13.

4.3.3.2 Building the LAN emulation client

The command `lane client Ethernet 11 S1Ethernet` creates an ELAN named S1Ethernet on the LANE module in slot 9 of the Catalyst 5500 UUT (Unit Under Test) and ties it to the previously defined VLAN 11.

```
cat5500-sup (enable) session 9
Trying ATM-9...
Connected to ATM-9.
Escape character is '^]'.

mod9>enable
mod9#config terminal
Enter configuration commands, one per line.  End with CNTL/Z.
mod9(config)#interface atm0.11 multipoint
mod9(config-subif)#lane client Ethernet 11 S1Ethernet
mod9(config-subif)#end
mod9#exit
cat5500-sup (enable)
```

Figure 82. Create LEC on Cisco 5500

4.3.3.3 Configuring the MPOA client

Each MPOA client, assuming the physical interface ATM0 is set up properly, must be configured at the global level, major interface, and subinterface level. At the global level we specify a shortcut frame count of 1 so that we will be able to observe traffic flowing in shortcut mode when the two PC workstations ping each other. Otherwise, the modest ping traffic would not generate enough traffic to exceed the default threshold of 10 frames in one second, at which the MPOA client will initiate a shortcut resolution.The `lane client` command is issued to the subinterface and associates the previously defined ELAN (and thus VLAN 11) with the MPOA client.

```
cat5500-sup (enable) session 9
Trying ATM-9...
Connected to ATM-9.
Escape character is '^]'.

mod9#config terminal
Enter configuration commands, one per line.  End with CNTL/Z.
mod9(config)#mpoa client config name mod9-mpc-01
mod9(mpoa-client-config)#shortcut-frame-count 1
mod9(mpoa-client-config)#interface atm0
mod9(config-if)#mpoa client name mod9-mpc-01
mod9(config-if)#interface atm0.11
mod9(config-subif)#lane client mpoa client name mod9-mpc-01
mod9(config-subif)#end
mod9#exit
cat5500-sup (enable)
```

Figure 83. Enabling MPC

4.3.3.4 Verifying the Catalyst MPOA client configuration

We may now display the LANE and MPC configurations by means of the `show` command. This provides useful information to verify the configuration and diagnose errors we may have made:

```
mod9#show lane default-atm-addresses
interface ATM0:
LANE Client:        39.0102030405060708090AA102.00D0BB6BA080.** 1
LANE Server:        39.0102030405060708090AA102.00D0BB6BA081.** 1
LANE Bus:           39.0102030405060708090AA102.00D0BB6BA082.** 1
LANE Config Server: 39.0102030405060708090AA102.00D0BB6BA083.00 1
note: ** is the subinterface number byte in hex

mod9#show lane client
LE Client ATM0.11  ELAN name: S1Ethernet  Admin: up  State: operational
Client ID: 3                 LEC up for 15 minutes 23 seconds
ELAN ID: 2
Join Attempt: 23
Known LE Servers: 1
Last Fail Reason: Control VC being released
HW Address: 00d0.bb6b.a080   Type: Ethernet             Max Frame Size: 1516  VL
ANID: 11
ATM Address: 39.0102030405060708090AA102.00D0BB6BA080.0B
 VCD  rxFrames  txFrames  Type       ATM Address
   0         0         0  configure  00.000000000000000000000000.000000000000.00
  93         4       487  direct     39.0102030405060708090AA102.000000000001.03 2
  94       479         0  distribute 39.0102030405060708090AA102.000000000001.03
  95         0       748  send       39.0102030405060708090AA102.000000000001.03
  96       108         0  forward    39.0102030405060708090AA102.000000000001.03
  97       340       344  data       39.0102030405060708090AA102.000000000001.05 3
```

Figure 84. LEC joined ELAN S1Ethernet

In Figure 84 we can see the status of the 5500 module:

1 The default ATM addresses that would be used for the Local LANE Client, LANE Server, LANE Bus and LANE Config Server.

2 Shows the LES for S1Ethernet on our MSS.

3 The router LEC on the MSS. The internal router has a connection to both ELANs. This is the 110.10.10.1 gateway.

```
mod9#show mpoa default-atm-addresses
interface ATM0:
MPOA Server: 39.0102030405060708090AA102.00D0BB6BA084.**
MPOA Client: 39.0102030405060708090AA102.00D0BB6BA085.**
note: ** is the MPS/MPC instance number in hex

mod9#show mpoa client

MPC Name: mod9-mpc-01, Interface: ATM0, State: Up
MPC actual operating address: 39.0102030405060708090AA102.00D0BB6BA085.00 1
Shortcut-Setup Count: 1, Shortcut-Setup Time: 1
Lane clients bound to MPC mod9-mpc-01: ATM0.11
Discovered MPS neighbours                   kp-alv   vcd     rxPkts     txPkts
39.0102030405060708090AA102.000000000001.06 33   100         73         16 2
```

Figure 85. MPC status

In Figure 85 we can see:

1 The ATM address of the Cisco MPC default address with instance (00). The ATM addresses are dynamically assigned instance by instance.

2 The MPS ATM address.

4.3.4 Verifying token-ring - Ethernet shortcut

Now we must verify that our MPS and MPCs are talking to each other and that we can establish shortcut routing between the Ethernet and token-ring segments. As shown in Figure 48 on page 77, we have two workstations, one connected to the 8270 and one to Cisco 5500.

We generate IP traffic by pinging 40.40.40.20 from 110.10.10.34, and vice versa pinging 110.10.10.34 from 40.40.40.20 simultaneously.

To verify what is happening, we will first take a look at the MPS Server in the MSS, then the Cisco MPC client in the 5500 blade, and finally see what is going on in the MSS client / MPC in the 8270 switch.

As already explained (Figure 75 on page 100), we tuned the configuration so that having one ping per second will force a shortcut to be established. This value would obviously not be chosen for a production environment. For a production environment, we suggest you start with the default value of 10 frames in one second and tune it if needed.

As you will see, the test showed no problems, and the shortcut was easily established between our clients.

4.3.4.1 MPS - MSS Server

Connecting to the MSS server, we type `TALK 5 -> Protocol MPOA -> MPS`. We are now able to look at specific details, and start with the command `Discovery`. Both MPC Clients have been discovered.

```
*TALK 5

+PROTOCOL MPOA

MPOA>MPS

MPS >DISCOVERY
                         DISCOVERY TABLE
 Net  Type  Age   MAC Addr/RD          ATM Address
 ---- ---- ----- ---------------- ----------------------------------------
 2     MPC 4014   400082700005        390102030405060708090AA10240008270000400 1
 3     MPC  260   0050047493AF        390102030405060708090AA10200D0BB6BA08500 2
 2     MPC  216           D221        390102030405060708090AA10240008270000400 1


MPS >CONTROL-VCCs
                     MPS Control VCCs
VPI  VCI  Net RefCnt MpcCnt Remote ATM Address
--- ----- --- ------ ------ ----------------------------------------
  0    70   0 6      1      390102030405060708090AA10200D0BB6BA08500 3
  0   130   0 8      3      390102030405060708090AA10240008270000400 3

MPS >IMPOSITION-CACHE LIST

  Total Cache Entries = 4
  MPOA Imposition Cache Entries
  ============================
 CacId  Destination Address     NextHop Address    State Htime Prot
 ----- -------------------- --------------------- ----- ----- ----
 6              40.40.40.20          40.40.40.20 Act    1628  IP 4
 7             110.10.10.34         110.10.10.34 Act    1788  IP 5
  Active Cache Entries = 2
```

Figure 86. Status of MPS

In Figure 86:

1 Shows the MSS client in the MPC Discovery table. There are two entries: one for the LEC, with MAC address 400082700005, and the other with the Route Descriptor for D221 LAN.

2 This is the Cisco 5500 MPC.

3 With the `Control-Vccs` command still on the MSS server, we can see that there are two connections: one VPI/VCI 0/70 to the Cisco MPC, and one with 0/130 to the 8270 MPC.

4 CacheID 6 from the MPS Imposition-Cache shows our workstation with IP address 40.40.40.20 from the token-ring network.

5 CacheID 7 shows our Ethernet workstation 110.10.10.34.

```
MPS >IMPOSITION-CACHE ENTRY 6
CacheId:     6
 State:       Active
 Elan-id:     1
 I-MPS Addr:  40.40.40.1
 Destination: 40.40.40.20
 NextHop:     40.40.40.20
 HoldingTime: 1598 seconds
 MTU size:    4490
 Prefix:      0xFF
 Elan-type:   Token Ring
 DLH Length:  28
 DLHeader:    00400006296871748000000000000206B0D221F0D0AAAA030000000800
I-MPC data ATM: 39010203040506070809OAA10200D0BB6BA08500 2
 E-MPC data ATM: 39010203040506070809OAA10240008270000400

MPS >IMPOSITION-CACHE ENTRY 7
CacheId:     7
 State:       Active
 Elan-id:     2
 I-MPS Addr:  110.10.10.1
 Destination: 110.10.10.34
 NextHop:     110.10.10.34
 HoldingTime: 1739 seconds
 MTU size:    1500
 Prefix:      0xFF
 Elan-type:   Ethernet DIX
 DLH Length:  14
 DLHeader:    0050047493AF0000000000030800
 I-MPC data ATM: 39010203040506070809OAA10240008270000400
 E-MPC data ATM: 39010203040506070809OAA10200D0BB6BA08500
```

Figure 87. MPS Imposition-Cache

Figure 87 shows the Imposition-cache Entry for 6 and 7. I-MPC means Ingress-MPC (cache) and E-MPC shows the Egress Cache.

4.3.4.2 MPC - Cisco 5500 MPOA Client

```
mod9#show mpoa client

MPC Name: mod9-mpc-01, Interface: ATM0, State: Up
MPC actual operating address: 39.010203040506070809OAA102.00D0BB6BA085.00
Shortcut-Setup Count: 1, Shortcut-Setup Time: 1
Lane clients bound to MPC mod9-mpc-01: ATM0.11
Discovered MPS neighbours                  kp-alv   vcd     rxPkts     txPkts
39.010203040506070809OAA102.000000000001.06    27   100        267         28 1
Remote Devices known                                vcd     rxPkts     txPkts
39.010203040506070809OAA102.400082700004.02         104          0          0 2
                                                    105         23         23
```

Figure 88. 5500 show mpoa client command

In Figure 88:

1 Shows the connection to the MPS in the MSS.

2 Shows that the MPC in the 8270 MSS client is known and established.

With the `show mpoa client` command shown in Figure 88, we verified that the Cisco MPC has discovered and is aware of the MPS and the 8270's MPC. Although it is not shown, the command `show mpoa client cache` verified that a shortcut route to the 8270 MPC client was established after we started pinging between the workstations.

4.3.4.3 MPC - IBM 8270 MSS Client

Now we will take a closer look at the MSS client in the 8270 switch. At the moment the shortcut is established, it will be the MPC function in the MSS client that has to do the fragmentation of the token frames. As can be seen starting from Figure 89, the MPC is up and running. We are again using `TALK 5`, but this time at the MSS client. Using the commands `MPC-BASE -> STATE -> LIST-CONFIG`, we can see:

```
MPC >MPC-BASE

MPOA Client Base Console
========================

MPC Base>STATE
          MPOA Client State:
          ==================

 ATM Interface Number:                  0
 State:                                 MPC UP STATE
 Time Since Last State Change (h:m:s):  01:54:20
 Last (internal) error code:            0
 Network-layer protocols enabled:       IP

MPC Base>LIST-CONFIG
          MPOA Client Configuration:
          =========================

   Status:                           ENABLED 1
   Shortcut Setup Frame Count:       1
   Shortcut Setup Frame Time:        2 (sec)
   Initial Retry Time:               5  (sec)
   Maximum Retry Time:                  40  (sec)
   Hold Down Time:                        160  (sec)
   VCC Timeout Period:                    20  (min)
   Accept Config From LECS:          Yes
   Fragmentation Mode:               Perform Fragmentation 2
   Interface:                        0
   ESI:                              40.00.82.70.00.04
   Selector:                         0
   Desired PCR:                      155000 (kbps)
   Maximum Reserved Bandwidth:      0 (kbps)
   Line Rate:                        155 (Mbps)
   Enable LANE Shortcuts:            TRUE 3
   Source MAC Address for Shortcuts: Burned In

          Packet Trace Filtering Parameters:
          =================================

   ATM Address Pkt Trace Filter Value
    0000000000000000000000000000000000000000
   ATM Address Pkt Trace Filter Mask
    0000000000000000000000000000000000000000
   LAN Pkt Trace Filter Value
    000000000000
   LAN Pkt Trace Filter Mask
    000000000000
```

Figure 89. Status of 8270 MPC client

Figure 89 shows:

1 The client is enabled.

2 It will perform fragmentation.

3 It is ready to do the LANE shortcut.

```
MPC >NEIGHBOR-MPSs
MPOA Client MPS Console
=======================

MPC MPS>LIST
          List of Neighbor MPSs for MPOA Client (interface 0):
          =====================================================
 1) Control ATM: 39.01.02.03.04.05.06.07.08.09.0A.A1.02.00.00.00.00.00.01.06 1

     1 MAC Address(es) Learnt For This MPS:

      1) MAC Addr: x00.00.00.00.00.02   Associated LEC Intf #:  5

MPC >VCCs
MPOA Client VCC Console
=======================

MPC VCC>LIST
          SVCs For MPC On ATM Interface 0 (total    3):
          =============================================
   1) VPI/VCI 0/447    State: OPERATIONAL
        Remote ATM: 39.01.02.03.04.05.06.07.08.09.0A.A1.02.00.00.00.00.00.01.06 2
   2) VPI/VCI 0/448    State: OPERATIONAL
        Remote ATM: 39.01.02.03.04.05.06.07.08.09.0A.A1.02.00.D0.BB.6B.A0.85.00 3
   3) VPI/VCI 0/449    State: OPERATIONAL
        Remote ATM: 39.01.02.03.04.05.06.07.08.09.0A.A1.02.00.D0.BB.6B.A0.85.00 4

MPC VCC>LIST-VCC
VPI, Range 0..255 [0]?
VCI, Range 0..65535 [0]? 447

  VPI/VCI: 0/447     State: OPERATIONAL    Calling Party: TRUE
  Hold Down Cause:  N/A   Cause Code: N/A   Fwd/Bak SDU:1536/1536
  Remote ATM Addr: 39.01.02.03.04.05.06.07.08.09.0A.A1.02.00.00.00.00.00.01.06
  Conn Type: P2P     VCC Type: B. EFFORT     Encaps. Type: LLC 1483
  H/W Path Valid: FALSE    Ref. Frame Cnt: 694
  Frames Tx/Rx: 66/732     Bytes Tx/Rx: 12379/52759

      (Direct) Shortcut Routes Using This VCC:
      ----------------------------------------
```

Figure 90. Status of the MPC Client, VCCs

Figure 90:

1 Typing `TALK 5 -> MPC -> NEIGHBOR-MPSs -> LIST`, we can see that there is one MPS in the list of Neighbor MPSs, and that it is the one on our MSS.

Typing `MPC -> VCCs -> LIST -> LIST-VCC`, we can see that there are three SVCs on VPI = 0; VCI 447, 448 and 449.

2 VCI 447 to the MPS in the MSS Server.

3 VCI 448 to the MPC in the 5500.

4 VCI 449 to our Workstation 110.10.10.34, and the shortcut route is RESOLVED. That can be seen in Figure 91.

```
MPC VCC>LIST-VCC
VPI, Range 0..255 [0]?
VCI, Range 0..65535 [0]? 448

  VPI/VCI: 0/448     State: OPERATIONAL    Calling Party: FALSE
  Hold Down Cause:  N/A   Cause Code: N/A   Fwd/Bak SDU:1508/1508
  Remote ATM Addr: 39.01.02.03.04.05.06.07.08.09.0A.A1.02.00.D0.BB.6B.A0.85.00
  Conn Type: P2P     VCC Type: B. EFFORT     Encaps. Type: LLC 1483
  H/W Path Valid: FALSE    Ref. Frame Cnt: 17883
  Frames Tx/Rx: 0/20899     Bytes Tx/Rx: 0/1504728

      (Direct) Shortcut Routes Using This VCC:
      ----------------------------------------

MPC VCC>LIST-VCC
VPI, Range 0..255 [0]?
VCI, Range 0..65535 [0]? 449

  VPI/VCI: 0/449     State: OPERATIONAL    Calling Party: TRUE
  Hold Down Cause:  N/A   Cause Code: N/A   Fwd/Bak SDU:1536/1536
  Remote ATM Addr: 39.01.02.03.04.05.06.07.08.09.0A.A1.02.00.D0.BB.6B.A0.85.00
  Conn Type: P2P     VCC Type: B. EFFORT     Encaps. Type: LLC 1483
  H/W Path Valid: FALSE    Ref. Frame Cnt: 17619
  Frames Tx/Rx: 20642/0     Bytes Tx/Rx: 1486224/0

      (Direct) Shortcut Routes Using This VCC:
      ----------------------------------------
     1) Address/Mask: 110.10.10.34/255.255.255.255    State: RESOLVED 5
```

Figure 91. MPC, List-VCCs

5 The state RESOLVED means a shortcut has been established for this connection.

```
MPC >INGRESS-CACHE
MPOA Client Ingress Cache Console

MPC INGRESS>LIST
          IP-Ingress Cache For MPC on ATM Interface 0
          ========================================

          Ingress Cache Entries for Direct Host Routes:
          --------------------------------------------
   1)  IP Address: 110.10.10.34         State: RESOLVED 1

          Ingress Cache Entries for Direct Network Routes:
          -----------------------------------------------

          Ingress Cache Entries for Derived Host Routes:
          ---------------------------------------------

MPC INGRESS>LIST-ENTRIES
Destination Protocol Address [0.0.0.0]? 110.10.10.34
Destination Protocol Address Mask [255.255.255.255]?

      Host Route Entries matching 110.10.10.34/255.255.255.255
      ---------------------------

          Direct Host Routes :

1) Address: 110.10.10.34  Shortcut State: RESOLVED 1
      Hold Down Cause: N/A   CIE Code: x0
      Dest ATM: 39.01.02.03.04.05.06.07.08.09.0A.A1.02.00.D0.BB.6B.A0.85.00
      Frames Sent To MPS: 12  Frames Sent Over Shortcut: 21169
      Remaining Age (mins:secs): 6:58      Last Request ID: x12
      Destn MTU: 1500       Encaps. Type: TAGGED 2
      LANE Encaps. Hdr: xN/A
      Tag Value: x6220007
      Shortcut VCC (VPI/VCI):    0/ 449   Local Shortcut ?: FALSE 3
      MPS: 39.01.02.03.04.05.06.07.08.09.0A.A1.02.00.00.00.00.00.01.06

          Derived Host Routes :

      Network Route Entries matching 110.10.10.34/255.255.255.255 4
      ------------------------------

None found!
```

Figure 92. Ingress Cache

From the MPC Ingress Cache shown in Figure 92, we can see that our IP address of the workstation is RESOLVED **1**, and a shortcut has been established.**2** The encapsulation is TAGGED, which is a MPOA format. Shortcut data frames use either a routed protocol encapsulation format defined in RFC1483, or an optional MPOA tagged encapsulation format.

FALSE Local Shortcut **3** means that the 8270 switch can make a local shortcut but in this case, we are making a connection across an ATM network. **4** shows the target address is 110.10.10.34.

```
MPC INGRESS>INGRESS-STATISTICS
      Ingress MPC Statistics For This MPC:
      ------------------------------------
   Frames forwarded to MPSs:              122
   Total Resolution Requests Sent:        28
   Total Refresh Res. Requests Sent:      2
   Total Res. Rqst Retransmissions:       19
   Total Res. Rqst Timeouts:              6
   Total Res. Reply Successes:            3
   Total Res. Reply NAKs:                 1
   Total Res. Replies Discarded:          0
   Total MPS Purges Recvd:                0
   Total MPS Purged Mappings:             0
   Total MPS Purges Discarded:            0
   Total Triggers Recvd:                  0
   Total Triggers Discarded:              0
   Total Keep Alives Recvd:               206
   Total Inactive Mappings Deleted:       0
   Total Frames Forwarded On Shortcuts:   5835
   Total Octets Forwarded On Shortcuts (H):0
   Total Octets Forwarded On Shortcuts (L):420120
   Total Data Plane Purges Recvd:         0
   Total Data Plane Purged Mappings:      0
   Total Data Plane Purges Discarded:     0
   Total NHRP Purge Replies Transmitted:  0

MPC >EGRESS-CACHE

MPOA Client Egress Cache Console
================================

MPC EGRESS>LIST
          Egress Cache For MPC on ATM Interface 0
          ========================================

      Egress Cache Entries w/ MPOA-Tag Encapsulation: 1
      -----------------------------------------------

   1) IP Address/Mask: 40.40.40.20       /255.255.255.255      State: ACTIVE 2

      Egress Cache Entries w/ Native 1483 Encapsulation (Host Routes):
      ----------------------------------------------------------------

      Egress Cache Entries w/ Native 1483 Encapsulation (Netwk Routes):
      -----------------------------------------------------------------
```

Figure 93. Ingress-Statistics and Egress-Cache

1 MPOA-Tag Encapsulation.

2 Resolved and active address 40.40.40.20.

Figure 94 shows the Egress Cache, with our 40.40.40.20 address and Encapsulation type TAG.

```
MPC EGRESS>LIST-ENTRIES 40.40.40.20
Destination Protocol Address Mask [255.255.255.255]?

      Egress Cache Entries matching 40.40.40.20/255.255.255.255 :

   1) Address/Mask: 40.40.40.20/255.255.255.255  Type: TAG
    LEC #:  5    Cache ID: x6   State: ACTIVE
    MPS: 39.01.02.03.04.05.06.07.08.09.0A.A1.02.00.00.00.00.00.01.06
    Source: 39.01.02.03.04.05.06.07.08.09.0A.A1.02.00.D0.BB.6B.A0.85.00
    Remaining Age (mins:secs): 39:30
    Recvd Octets (H): 0    Recvd Octets (L): 1045584
    Recvd Frames Forwarded: 14522
    Recvd Frames Discarded: 0
    Tag Value: x1       Local Shortcut: FALSE
    DLL Header: x00400006296871748000000000000206b0d221f0d0aaaa030000000800
    LANE Extensions in last Imposition reply:  None
```

Figure 94. MPC Egress Cache

Figure 95 shows us the MPC's MPOA statistics.

```
MPC EGRESS>EGRESS-STATISTICS
      Egress MPC Statistics For This MPC:
      -----------------------------------
   Total Imposition Requests Recvd:       19
   Total Imposition Rqsts NAKed:          0
   Total Imposition Updates Received:     14
   Total Imposition Purges Received:      1
   Total Imposition Purged Mappings:      1
   Total E-MPC Purge Rqsts Sent To MPSs:  0
   Total E-MPC Purge Rqst Retransmissions: 0
   Total E-MPC Purge Rqst Timeouts:       0
   Total Octets Recvd (Software Path) (H): 0
   Total Octets Recvd (Software Path) (L): 1047384
   Tot. Frames Recvd & Fwded (Software):   14547
   Tot Frames Recvd (Hardware, Released VCCs): 0
   Total Recvd Frames Discarded:          0
   Total Data Plane Purge Rqsts Sent:     0
   Total Data Plane Purge Rqst Retransmits:0
   Total Data Plane Purge Rqst Timeouts:   0
   Total Egress Cache Entries Aged Out:    1
```

Figure 95. Egress-Statistic

4.3.4.4 IBM 8265 VCCs

```
8265_C2> show signalling cross_connections port 14.3

In: slot.port vpi.vci   type  Out: slot.port vpi.vci   type      Conn  Cat
------------------------------------------------------------------------------
      14.3      0.440    svc           7.1      0.123    svc       p2p  ubr
      14.3      0.441    svc           7.1      0.124    svc       p2m  ubr
      14.3      0.442    svc           7.1      0.125    svc       p2p  ubr
      14.3      0.443    svc           7.1      0.126    svc       p2m  ubr
      14.3      0.445    svc           7.1      0.128    svc       p2p  ubr
      14.3      0.447    svc           7.1      0.130    svc       p2p  ubr
      14.3      0.448    svc          16.3      0.169    svc       p2p  ubr
      14.3      0.449    svc          16.3      0.170    svc       p2p  ubr

Total number of cross connections = 8
8265_C2> show signalling cross_connections port 16.3

In: slot.port vpi.vci   type  Out: slot.port vpi.vci   type      Conn  Cat
------------------------------------------------------------------------------
      16.3      0.156    svc           7.1      0.64     svc       p2p  ubr
      16.3      0.157    svc           7.1      0.65     svc       p2m  ubr
      16.3      0.158    svc           7.1      0.66     svc       p2p  ubr
      16.3      0.159    svc           7.1      0.67     svc       p2m  ubr
      16.3      0.160    svc           7.1      0.68     svc       p2p  ubr
      16.3      0.162    svc           7.1      0.70     svc       p2p  ubr
      16.3      0.169    svc          14.3      0.448    svc       p2p  ubr
      16.3      0.170    svc          14.3      0.449    svc       p2p  ubr

Total number of cross connections = 8
```

Figure 96. VCCs between the two MPCs

In Figure 96 the `show signalling cross_connections port` command shows the direct connection between port 14.3 with the 8270 and port 16.3 with the Cisco 5500. A shortcut is established.

Appendix A. IBM 8265 configuration for the MPOA test

The configuration of the IBM 8265 switch is listed for your reference.

```
8265_C2> show device

8265 ATM Control Point and Switch Module
Name : 8265ATM
Location : IBM LAB RTP
For assistance contact :
Manufacture id: 930
Part Number: 02L3457 EC Level: F12519
Boot EEPROM version: v.4.1.3
Flash EEPROM version: v.4.1.3 (PNNI)1
Flash EEPROM backup version: v.4.1.2 (PNNI)
Last Restart : 15:11:10 Tue 18 Jan 2000 (Restart Count: 116)

A-CPSW
--------------------------------------------------------------------------------
 > Subnet ethernet: Up
    IP address: 10.10.10.202. Subnet mask: FF.FF.FF.00
    MAC Address: 0006291F92EB (BIA)
 > Subnet atm: Up
    IP address: 198.1.1.2. Subnet mask: FF.FF.FF.00

> Subnet lan emulation ethernet/DIX
    Up
    Config ELAN Name :"S1Ethernet"
    Actual ELAN Name :"S1Ethernet"
    MAC Address: 0006291F12EB
    IP address : 110.10.10.202. Subnet mask: FF.FF.FF.00
    ATM address    :39.01.02.03.04.05.06.07.08.09.0A.A1.02.00.00.00.00.A1.02.00
    Config LES addr:none
    Actual LES addr:39.01.02.03.04.05.06.07.08.09.0A.A1.02.00.00.00.00.00.01.03
    BUS ATM address:39.01.02.03.04.05.06.07.08.09.0A.A1.02.00.00.00.00.00.01.03
    Config LECS add:none
    Actual LECS add:39.01.02.03.04.05.06.07.08.09.0A.A1.02.00.00.00.00.00.01.00 2
    LEC Identifier: 2. Maximum Transmission Unit: 1492
 > Subnet lan emulation token ring
    Not Started
    Config ELAN Name :""
    Actual ELAN Name :""
    MAC Address: 0006297712EB
    IP address : 0.0.0.0. Subnet mask: 00.00.00.00
    ATM address    :39.01.02.03.04.05.06.07.08.09.0A.A1.02.00.00.00.00.A1.02.01
    Config LES addr:none
    Actual LES addr:00.00.00.00.00.00.00.00.00.00.00.00.00.00.00.00.00.00.00.00
    BUS ATM address:00.00.00.00.00.00.00.00.00.00.00.00.00.00.00.00.00.00.00.00
    Config LECS add:none
    Actual LECS add:00.00.00.00.00.00.00.00.00.00.00.00.00.00.00.00.00.00.00.00
    LEC Identifier: 0. Maximum Transmission Unit: 0
```

Figure 97. 8265 Configuration, Part 1 of 2

```
Default Gateway : OK
-------------------------------------------------------------------------------
 IP address: 10.10.10.1

ARP Server:
-------------------------------------------------------------------------------
 ATM address: 39.99.99.99.99.99.99.00.00.99.99.33.01.08.00.5A.99.0D.54.00

Device configured for PNNI port capability.
Device configured for Lan Emulation Servers.
Dynamic RAM size is 32 MB. Migration: off. Diagnostics: enabled.
Device defined as primary.
Memory profile: Mixed (32_P_M)
Duplicate ATM addresses are allowed.
Accounting is disabled.
```

Figure 98. 8265 Configuration Part 2 of 2

1 8265 Operational Code level.

2 LECS address.

```
8265_C2> show module all

Slot Install Connect Operation General Information
-------------------------------------------------------------------------------
  1     n       n       n     -
  2     n       p       n     -
  3     Y       Y       Y     8265 ATM 3 Ports LAN 155 Mbps Module
  4     n       p       n     -
  5     Y       n       n     -
  6     n       p       n     -
  7     Y       Y       Y     8265 A-MSS 3 (FC5403) Module 1
  8     n       p       n     -
  9     Y       Y       Y     8265 ATM Control Point and Switch Module:Active 1
 10     Y       n       n     < Extension >
 11     n       p       n     -
 12     Y       Y       Y     8265 ATM 622 Mbps Module
 13     Y       n       n     -
 14     Y       Y       Y     8265 ATM 4 ports 155 Mbps Module 1
 15     Y       Y       Y     8265 ATM 4 ports 155 Mbps Module
 16     Y       Y       Y     8265 ATM 4 ports 155 Mbps Module 1
 17     Y       Y       Y     8265 ATM 4 ports 155 Mbps Module
 18     n       n       n     -
 19     Y       n       Y     Active Controller ModuleThis is screen.
```

Figure 99. IBM 8265 Configuration

1 These modules were used for this test.

```
8265_C2> show port 7.1 verbose

     Type  Mode     Status                           Daughter Card Description
-------------------------------------------------------------------------------
 7.01:UNI  enabled  UP                               A-MSS 3 (FC5403)

UNI Type             : Private
Signalling Version   : Auto
> Oper Sig. Version  : 3.0
ILMI status          : UP
ILMI vci             : 0.16
RB Bandwidth         : unlimited
Signalling vci       : 0.5
RB Admin weight      : 5040
NRB Admin weight     : 5040
VPI range admin.     : 0-15 (4 bits)
VCI range admin.     : 0-1023 (10 bits)
VPI range oper.      : 0-7 (3 bits)
VCI range oper.      : 0-1024 (10 bits)
Connector            : NONE
Media                : none
Port speed           : 155000 kbps
Connection shaping   : Off.
Remote device is active


ATM MSS Server Card Information:
--------------------------------
 P/N:31L3352  EC level:F53160  Manufacture:RAL0
 Model Number               : 5401
 Operational Status         : OKAY
 Boot Code Version          : v.4.0.0
 Operational Code Version   : v.2.2.0
 IP address                 : 40.40.40.1
 IP Subnet Mask             : 0.0.0.0

Physical Port:   Status   Network   Speed   Connector   MAC Address
------------------------------------------------------------------
 01              OKAY     ATM       N/A     Backplane   00062999FF0C
```

Figure 100. Port 7 - MSS Blade

```
8265_C2> show port 14.3 verbose

      Type Mode     Status
-------------------------------------------------------------------------------
14.03: UNI enabled  UP

UNI Type             : Private
Signalling Version   : Auto 1
> Oper Sig. Version  : 3.0 2
ILMI status          : UP
ILMI vci             : 0.16
RB Bandwidth         : unlimited
Police admin.        : on
Police oper.         : on
Signalling vci       : 0.5
RB Admin weight      : 5040
NRB Admin weight     : 5040
VPI range admin.     : 0-15 (4 bits)
VCI range admin.     : 0-1023 (10 bits)
VPI range oper.      : 0-7 (3 bits)
VCI range oper.      : 0-1024 (10 bits)
Connector            : SC DUPLEX
Media                : multimode fiber
Port speed           : 155000 kbps
Connection shaping   : Off.
Remote device is active

Frame format    : SONET STS-3c
Scrambling mode : frame and cell
Clock mode      : internal
```

Figure 101. Port 14.3 - IBM 8270 Token-Ring Switch MSS Client Connection to port 14.3

The port 14.3 UNI type is set to Private. The signalling version is set to Auto **1**. Operational Signalling Version is discovered to be 3.0 **2**. Signalling is up and running.

```
8265_C2> show port 16.3 verbose

      Type Mode     Status
-------------------------------------------------------------------------------
16.03: UNI enabled  UP

UNI Type             : Private
Signalling Version   : Auto 1
> Oper Sig. Version  : 3.1 2
ILMI status          : UP
ILMI vci             : 0.16
RB Bandwidth         : unlimited
Police admin.        : on
Police oper.         : on
Signalling vci       : 0.5
RB Admin weight      : 5040
NRB Admin weight     : 5040
VPI range admin.     : 0-15 (4 bits)
VCI range admin.     : 0-1023 (10 bits)
VPI range oper.      : 0-3 (2 bits)
VCI range oper.      : 0-1024 (10 bits)
Connector            : SC DUPLEX
Media                : multimode fiber
Port speed           : 155000 kbps
Connection shaping   : Off.
Remote device is active

Frame format    : SONET STS-3c
Scrambling mode : frame and cell
Clock mode      : internal.
```

Figure 102. Cisco 5500 Dual OC-3 Port Module Connection to port 16.3

The port 16.3 is connected to the Cisco 5500 Switch. The port UNI type is set to Private. The signalling version set to Auto **1**. Operational Signalling Version is discovered to be 3.1 **2**. Signalling is up and running.

Appendix B. Cisco 5500 configuration listing for the MPOA test

The configuration of the Cisco 5500 MPOA client is given here as a reference. We will not discuss it in detail but only list the core configuration parameters required to run a MPC LEC. Please refer to the Cisco documentation at `http://www.cisco.com` for a more detailed description of the commands and configuration parameters used in this example.

```
Cisco System Console Mon Feb 7 2000, 12:22:09
Catalyst5500 switch Configuration
cat5500-sup (enable) show config
#version 4.5(1)
set prompt cat5500-sup
#ip
set interface sc0 1 10.10.10.248 255.255.255.0 10.10.10.255
set interface sc0 up
set arp agingtime 1200
set ip route 0.0.0.0 10.10.10.242 1
!
#vtp
set vtp domain cisco
set vtp mode server
set vtp v2 disable
set vtp pruning disable
set vtp pruneeligible 2-1000
clear vtp pruneeligible 1001-1005
set vlan 1 name default type ethernet mtu 1500 said 100001 state active
set vlan 11 name VLAN0011 type ethernet mtu 1500 said 100011 state activ
set spantree enable all
#vlan1
set spantree fwddelay 15 1
set spantree hello 2 1
set spantree maxage 20 1
set spantree priority 8192 1
#vlan11
set spantree fwddelay 15 11
set spantree hello 2 11
set spantree maxage 20 11
set spantree priority 32768 11
#set boot command
set boot config-register 0x102
set boot system flash bootflash:cat5000-sup3.4-5-1.bin
!
#module 1 : 0-port supervisor III
set module name 1
!
```

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```
#module 2 : 12-port 10/100BaseTX Ethernet (not used)
!
OC12 Dual PHY MMF (not used)
!
#module 4 : 2-port MM OC-3 Dual-Phy ATM (not used)
!
#module 5 empty
!
#module 6 empty
!
module 7 : 24-port 10/100BaseTX Ethernet
set module name 7
set modul enable 7
set vlan 1 7/4-9,7/23-24
set vlan 11 7/3,7/13
set port enable 7/1-24
set port level 7/1-24 normal
set port speed 7/1-24 auto
set port trap 7/1-24 disable
set port name 7/1-24
set port security 7/1-24 disable
set port broadcast 7/1-24 0
set portmembership 7/1-24 static
set port protocol 7/1-24 ip on
set port protocol 7/1-24 ipx auto
set cdp enable 7/1-24
set cdp interval 7/1-24 60
set spantree portfast 7/23 enable
set spantree portfast 7/1-22,7/24 disable
set spantree portcost 7/2,7/9,7/11,7/13-14,7/24 19
set spantree portcost 7/1,7/3-8,7/10.7/12,7/15-23 100
set spantree portpri 7/1-24 32
!
#module 8 empty
!
#module 9 : 2-port MM OC-3 Dual-Phy ATM
set module name 9
set port level 9/1 normal
set port name 9/1-2
set cdp enable 9/1
set cdp interval 9/1 60
set trunk 9/1 on lane 1-1005
set spantree portcost 9/1 14
set spantree portpri 9/1 32
set spantree portvlanpri 9/1 0
set spantree portvlancost 9/1 cost 13
!
```

```
#module 10 empty
!
#module 11 empty
!
#module 12 empty
!
#module 13 empty
!
cat5500-sup
cat5500-sup (enable) session 9
Trying ATM-9...
Connected to ATM-9.
LEC - LANE modul configuration
mod9>enable
mod9#show config
Using 911 out of 523258 bytes
!
!Last configuration change at 10:09:39 UTC Fri Feb 4 2000
!NVRAM config last updated at 10:09:41 UTC Fri Feb 4 2000
!
version 12.0
service timestamps debug uptime
service timestamps log uptime
no service password-encryption
!
hostname mod9
mpoa client config name mod9-mpc-01
shortcut-frame-count 1
!
interface Ethernet0
!
interface ATM0
atm preferred phy A
atm pvc 1 0 5 qsaal
atm pvc 2 0 16 ilmi
no atm ilmi-keepalive
mpoa client name mod9-mpc-01
!
interface ATM0.11 multipoint
lane server-atm-sddress
39.01020304050607080900AA102.0000000000001.03
lane client mpoa clinet name mod9-mpc-01
lane client ethernet 11 S1Ethernet
!
line con 0
line vty 0 4
exec-timeout 0 0
```

```
no login
```

Appendix C. Special notices

This publication is intended to help users of IBM Ethernet and ATM switches plan growth and eventual migration of existing networks. The information in this publication is not intended as the specification of any programming interfaces that are provided by IBM Ethernet and ATM switches. See the PUBLICATIONS section of the IBM Programming Announcement for IBM Ethernet and ATM switches for more information about what publications are considered to be product documentation.

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Appendix D. Related publications

The publications listed in this section are considered particularly suitable for a more detailed discussion of the topics covered in this redbook.

D.1 IBM Redbooks

For information on ordering these publications see “How to get IBM Redbooks” on page 135.

- *MSS Release 2.1 Including the MSS Client and Domain Client*, SG24-5231
- *IBM Router Interoperability and Migration Examples*, SG24-5865
- *ATM Configuration Examples*, SG24-2126
- *Application-Driven Networking: Class of Service in IP, Ethernet and ATM Networks,* SG24-5384
- *Layer 3 Switching Using MSS and MSS Release 2.2 Enhancements,* SG24-5311
- *Application Driven Networking: Concepts and Architecture for Policy-Based Systems,* SG24-5640

D.2 IBM Redbooks collections

Redbooks are also available on the following CD-ROMs. Click the CD-ROMs button at http://www.redbooks.ibm.com/ for information about all the CD-ROMs offered, updates and formats.

CD-ROM Title	Collection Kit Number
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Application Development Redbooks Collection	SK2T-8037
IBM Enterprise Storage and Systems Management Solutions	SK3T-3694

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D.3 Other resources

These publications are also relevant as further information sources:

- *CLSC Exam Certification Guide,* ISBN 0-7357-0875-4
- *CCIE Professional Development: Cisco LAN Switching*, ISBN 1-57870-094-9

D.4 Referenced Web sites

`http://www.redbooks.ibm.com`

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